Credit & Rates Markets
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HEAT™ Technical Document: A consistent framework for assessing hedge effectiveness under IAS39 and FAS133

- **HEAT is JPMorgan's Hedge Effectiveness Analysis Toolkit**
- **Helps corporations navigate the complexities of hedge effectiveness testing**
- **Provides a toolkit for hedge effectiveness testing under IAS 39 and FAS 133**
- **Toolkit comprises a consistent framework incorporating alternative methodologies for understanding and implementing hedge effectiveness testing**
- **Enables corporations to assess the effectiveness of hedges in both economic and accounting terms**
- **Enables corporations to estimate the potential impact on earnings if hedge accounting is not obtained**

While HEAT provides corporations with a consistent framework incorporating many alternative methodologies for hedge effectiveness testing, the appropriateness of any given methodology from an accounting perspective will be determined by auditors, and as such accounting advice should be sought before implementing a particular methodology.

A toolkit to help corporations navigate the complexities of hedge effectiveness testing under IAS 39 and FAS 133 accounting standards.

Guy Coughlan
(44-20) 7777-1857
guy.coughlan@jpmorgan.com
Asset-Liability Management Advisory
J.P. Morgan Securities Ltd.

Johannes Kolb
(44-20) 7777-1301
johannes.kolb@jpmorgan.com
Derivatives Marketing
JPMorgan Chase Bank

Simon Emery (ACA)
(44-20) 7777-4128
simon.emery@jpmorgan.com
Derivatives Marketing
JPMorgan Chase Bank

heat.enquiries@jpmorgan.com
(44-20) 7777-1309

JPMorgan

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

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Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Chapter 1. Introduction

1.1 The accounting background

The introduction of IAS 39 for International Accounting Standards reporting and FAS 133 for US GAAP reporting has radically changed the recognition and measurement of financial derivatives. Both these standards require derivatives to be recognised on the balance sheet at fair value. Furthermore, unless they are designated as part of a hedging relationship which qualifies for hedge accounting treatment, derivative instruments can create additional earnings volatility. Many corporations find this volatility undesirable due to the adverse impact it may have on the views of rating agencies, analysts and investors.

In order to qualify for hedge accounting, and thereby avoid unwanted earnings volatility, a derivative must be formally designated as a hedge at its inception. Furthermore, in all but limited circumstances, a numerical hedge effectiveness test must be undertaken and passed both at inception and throughout the life of the hedge relationship.

Although IAS 39 and FAS 133 are highly complex and detailed, they both recognise the need for flexibility in addressing hedge effectiveness. As a result, corporations have leeway in the implementation of hedge effectiveness testing in order to ensure that it is appropriately aligned with their risk management policy. While leaving room to identify an appropriate methodology for effectiveness testing is essential, the lack of explicit implementation guidance provides insufficient direction for all but the most sophisticated companies.

1.2 Implications for corporate hedging

The new accounting standards have far-reaching implications for corporate hedging practices. Risk management policies that have historically been designed around economic considerations are in danger of becoming overwhelmingly accounting driven. Indeed we have already seen this happening both in the US and in Europe.

Many corporations that are already reporting under either IAS or US GAAP have completely changed their approach to risk management. The welcome side to this change is the increased focus on ensuring that all derivative hedges are economically appropriate. However, there is also an unwelcome side. For many of these corporations, risk management policy has become dominated by accounting considerations. Hedges that provide real economic benefit are being avoided because of the complexities and uncertainties associated with accounting.

Faced with the new standards, corporations have three choices. The first is not to hedge. The second is to hedge but to ignore hedge accounting, thereby accepting the additional earnings volatility on all derivative hedges in the knowledge that the underlying economic benefits remain. The third choice is to hedge and seek hedge accounting treatment based on an effectiveness test to avoid additional volatility in earnings coming from *bona fide* economic hedges. This decision will be driven by materiality of the additional earnings volatility and its impact on shareholders and debtholders.

Given that corporations with more stable earnings streams tend to have lower costs of capital, it is not surprising that the third choice is the most desirable. But to gain the maximum accounting benefit it is essential to ensure that the hedge effectiveness methodology is appropriate. An inappropriate test may be worse than no test at all, since it may lead to misleading results and unsuitable hedging decisions.

1.3 What is HEAT?

HEAT is a response to the challenges described above: a practical Hedge Effectiveness Analysis Toolkit. It provides a consistent framework to help corporations navigate the complexities of hedge effectiveness testing. In particular, HEAT enables corporations to address in a consistent manner issues such as:

- How to approach hedge effectiveness
- How to select an appropriate effectiveness testing methodology
- What are the pitfalls that need to be avoided?
- When is hedge accounting undesirable?
- Does the economic benefit of hedging outweigh the accounting impact?
- What are the relative benefits of alternative hedging instruments?

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

As its name suggests HEAT is not one rigid methodology, but a toolkit of many alternative methodologies for evaluating the effectiveness of hedges from both the accounting perspective and the economic perspective. It provides the tools to help corporations identify and implement the optimal methodology for hedge effectiveness testing, whatever their hedging objectives.

The alternative methodologies have various advantages and disadvantages, and different ones will be appropriate for different businesses in different hedging situations. Some methodologies are economically sophisticated, others economically naive. From an accounting perspective the appropriateness of a particular methodology will ultimately be determined by each corporation's auditor. Corporations must, therefore, seek the appropriate advice from their auditor before implementing a particular methodology.

It is important to note that the optimal hedge effectiveness methodology in the context of FAS 133 is likely to be different from the optimal methodology in the context of IAS 39, and different from the optimal methodology in the context of economic performance. By providing a flexible framework for evaluating hedge effectiveness, HEAT enables corporations to address hedge effectiveness decisions consistently, regardless of how they view the trade-off between their economic and accounting performance.

Although the new accounting standards were the main motivation behind HEAT, the framework is based on very general principles and can be applied in any hedging situation.

1.4 How this document is organised

We begin in Chapter 2 with a discussion of what hedge effectiveness means in intuitive terms. This leads us to define the concept of the 'perfect hedge' which is 100% effective in terms of eliminating the impact of the designated risk on the appropriate performance metric. The perfect hedge is a central concept in all approaches to hedge effectiveness as it defines the standard against which all other hedges should be compared. It is also the primary point of reference for understanding hedge effectiveness.

The final section of this chapter describes how hedge effectiveness is measured in economic terms. This helps guide the choice of an appropriate methodology under the accounting standards.

Chapter 3 then provides a summary of the main aspects of hedge effectiveness according to both IAS 39 and FAS 133. In this chapter we point out how the concept of the 'perfect hedge' plays a role (both explicitly and implicitly) in these accounting standards. The chapter then moves on to discuss what the standards mean by 'highly effective' hedges and the different methods for evaluating effectiveness. Readers already familiar with the standards may want to skip most of this chapter, but should as a minimum read Section 3.1.

Chapter 4 takes a much more practical perspective of effectiveness. In it we present three detailed examples of simple effectiveness tests for fair value hedges of interest-rate risk. These examples use real data to demonstrate how even relatively simple hedge effectiveness methodologies can give surprising and sometimes counter-intuitive results. These examples demonstrate some of the potential pitfalls that need to be negotiated in developing a consistent and intuitive approach to evaluating hedge effectiveness.

Then Chapter 5 provides a detailed presentation of the HEAT framework for evaluating hedge effectiveness. This framework involves five main steps which can be customised to any hedging application:

- Step 1: Define hedging objectives
- Step 2: Select hedging instrument
- Step 3: Select methodology for hedge effectiveness evaluation
- Step 4: Evaluate hedge effectiveness
- Step 5: Interpret effectiveness results

Step 3 is clearly a vitally important part of the framework as the choice of an inappropriate methodology for hedge effectiveness can give inconsistent and misleading results. This step involves seven distinct elements:

1. Reference exposure
2. Fair value approach
3. Historical data to be used
4. Method of applying historical data
5. Maturity treatment
6. Basis for comparison
7. Type of effectiveness test

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

A key element in the HEAT framework is the concept of the 'perfect hedge' discussed above, which in an accounting context we refer to as the 'Ideal Designated-Risk Hedge', or IDRH. The IDRH plays an important role in validating the economic appropriateness of any hedge effectiveness methodology.

Chapter 5 concludes with an example of effectiveness evaluation applied to a hedge of foreign exchange (FX) risk.

Throughout this document, the examples and discussion focus primarily —but not exclusively— on hedges of interest-rate risk, specifically fair value and cash flow hedges of interest-rate risk. It is with fair value hedges of interest-rate risk that the most obvious challenges lie in terms of evaluating hedge effectiveness in a consistent and meaningful manner under the accounting standards. However, as we have already emphasised the HEAT framework is completely general and applicable in principle to all types of hedging relationships (i.e., cash flow hedges, fair value hedges, net investment hedges, and pure economic hedges), as well as all risk classes (i.e., interest-rate risk, credit risk, foreign exchange risk, commodity price risk, etc.).

1.5 Terminology

In what follows we shall collectively refer to IAS 39 and FAS 133 (along with the amendments published in FAS 138) as 'the accounting standards' or simply 'the standards'. Furthermore, we shall on occasion refer to the hedged item in a hedging relationship as the 'underlying', in accordance with common market parlance.

The Appendix contains a Glossary which provides working definitions of the key concepts associated with hedging, hedge effectiveness and the accounting standards.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

JPMorgan

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Chapter 2. Intuition behind hedge effectiveness

In this chapter we explore what hedge effectiveness means intuitively. The intuition behind what makes an effective hedge must ultimately come from an economic perspective, although its implementation may well be influenced by accounting considerations. Indeed the motivation behind both FAS133 and IAS39 has been the desire to more accurately capture the economic characteristics of derivatives in the financial accounts of corporations. Hedge effectiveness, therefore, should distinguish between those derivatives that are truly playing a risk management role in an economic sense and those that are largely speculative.

While, as already mentioned, both accounting standards leave significant leeway in the specific method for hedge effectiveness testing, the guidelines they provide are based on the requirement that corporations explicitly demonstrate the high effectiveness of every hedge, but in an accounting context. Clearly, this economic motivation and the associated intuition should be taken into account in developing an approach to hedge effectiveness testing. Any approach that fails to reflect, or worse contradicts, this intuition must be considered inappropriate from an economic perspective.

2.1 Defining effectiveness

Before we can evaluate the consistency and appropriateness of a particular approach to hedge effectiveness, we first need to define what we mean intuitively by effectiveness.

Hedge effectiveness reflects the degree to which changes in the performance of an underlying risk exposure, i.e., underlying hedged item, in respect of a designated risk are offset by changes in the performance of a designated hedging instrument.

From this intuitive definition, effectiveness clearly depends on the specific hedging objectives which are reflected in two key factors:

- the specific performance metric being used
- the designated risk being hedged

The performance metric defines the way in which hedge effectiveness should be measured. For example, if the relevant performance metric is cash flow, then effectiveness needs to be evaluated in terms of hedging the impact of the risk on cash flow. Similarly, if the relevant performance metric is economic fair value, then effectiveness must be evaluated in terms of fair (or marked-to-market) value.

The ‘designated risk’ refers to the specific risk factor that is the object of the hedge. In practice a hedged item will be exposed to several risk factors. For example, a bond issued by a corporation in a foreign currency is subject to interest rate risk, foreign exchange risk, swap spread risk, issuer credit spread risk and issuer default risk. Because different risks interact in a highly non-linear way it is absolutely essential that hedge effectiveness assessments focus purely on the designated risk, and exclude the effects of other risks. In practice this is extremely difficult and, as we demonstrate later in this paper, gives rise to many of the problems associated with existing approaches.

2.2 The concept of the ‘perfect hedge’

Intuitively, hedge effectiveness reflects how well a hedging instrument performs in terms of protecting the underlying hedged item from undesirable changes with respect to the designated risk. To be ‘perfectly effective’, a hedge must completely eliminate undesirable changes in the performance of the underlying exposure to the designated risk. If a hedge is not perfectly effective, then the degree of ineffectiveness measures the extent to which the hedge contains elements unrelated to the risk being hedged. Hence it is necessary to specify exactly what we mean by the ‘perfect hedge’.

A *perfect hedge* is a hedge that is perfectly effective over the life of the hedging relationship, such that changes in the performance of the hedging instrument precisely offset the changes in the performance of the underlying hedged item, in respect of the designated risk being hedged.

So intuitively, the perfect hedge should completely eliminate the economic impact of the designated risk on the relevant performance metric. It also follows that, since a perfect hedge performs a valid risk-management role in an economic sense, it should in principle lead to no earnings volatility in relation to the designated risk being hedged. In other words, a perfect hedge should qualify for hedge accounting treatment, with no ineffectiveness.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

By way of illustration, consider the perfect cash flow hedge of the interest-rate risk of a floating-rate bond. Such a perfect hedge will completely eliminate the cash flow volatility of the bond's floating coupons coming from interest-rate risk. Furthermore, in principle the only impact on earnings should be through the changes in the cash flows that were the object of the hedge. Hence the combination of a floating-rate bond plus a perfect cash flow interest rate hedge is equivalent to a fixed-rate bond in both economic terms and should in principle also be the case from an accounting perspective.

Table 2.1 shows a specific example of an intuitively perfect cash flow hedge where designated risk is interest-rate risk (specifically Libor). The underlying is a debt instrument, more specifically a floating-rate note (FRN), with a maturity of five years and a coupon specified in terms of 6-month Libor paid semi-annually. The perfect cash flow hedge is an interest-rate swap of the same maturity for which the pay leg is fixed rate and the interest-rate characteristics of the receive leg precisely match those of the underlying FRN. In other words, we have a precise match between all the 'critical terms' of the hedge and underlying.

Table 2.2 shows a specific example of an intuitively perfect fair-value hedge where designated risk is interest rate risk. Again the underlying is a debt instrument but this time it is a fixed-rate bond, paying an annual fixed-rate coupon. The perfect fair-value hedge in this case is an interest-rate swap of the same maturity as the bond for which the pay leg is floating and the interest-rate characteristics of the receive leg precisely match those of the bond. Once again, all the 'critical terms' of the hedge and underlying match.

2.3 Evaluating effectiveness

In reality many of the hedges that corporations contemplate are not perfect hedges, but nevertheless play an effective role in reducing risk. As long as the hedging instrument provides a material level of economic offset between its performance and the performance of the hedged item in terms of the designated risk, then most people would conclude that the hedge should be deemed effective and should be given favourable hedge accounting treatment. On the other hand, if the level of economic offset is not significant, then the hedge should be deemed ineffective and should not qualify for hedge accounting. This concept of effectiveness is a cornerstone of hedge qualification under both accounting standards.

On the basis of the foregoing discussion we conclude that for a framework for hedge effectiveness to be consistent it should address the extent to which the actual hedging instrument falls short of being a perfect hedge. It follows that the most direct way of evaluating the effectiveness of a particular hedge is in terms of the performance mismatch between the actual hedging instrument and the appropriate perfect hedge in terms of the designated risk.

Table 2.1: Example of a 'perfect' cash flow hedge of interest-rate risk

	Underlying Hedged Item	Hedging Instrument	
	Floating-Rate Note	**Interest-Rate Swap**	
Position	Debt	Pay fixed-rate	
Settlement date	5 March 2002	5 March 2002	
Maturity date	5 March 2007	5 March 2007	
Coupon	Pay: 6 month Libor	Receive: 6 month Libor	Pay: Fixed Rate
	Semi-annual on 5 Mar and 5 Sep	Semi-annual on 5 Mar and 5 Sep	Semi-annual on 5 Mar and 5 Sep

Table 2.2: Example of a 'perfect' fair value hedge of interest-rate risk

	Underlying Hedged Item	Hedging Instrument	
	Fixed-Rate Bond	**Interest-Rate Swap**	
Position	Debt	Receive fixed-rate	
Settlement date	5 March 2002	5 March 2002	
Maturity date	5 March 2007	5 March 2007	
Coupon	Pay: 4.24%	Receive: Fixed rate 4.24%	Pay: 6 month Libor
	Annual on 5 Mar	Annual on 5 Mar	Semi-annual on 5 Mar and 5 Sep

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

2.4 Calculating hedge effectiveness in economic terms

Hedge effectiveness has only recently become a major accounting issue, but it is a subject with a much longer history. The initial research emphasised the economic — rather than the accounting — perspective and was set in the context of hedging in the futures markets. But many of the early research papers still provide a useful introduction to the general issues connected with evaluating hedge effectiveness (see Johnson (1960), Ederington (1979) and Franckle (1980)). For a more general discussion of corporate hedging see, for example, Culp and Millar (1999).

In this section we describe a simple model to illustrate the economic performance of hedges and what effectiveness means in this context.

2.4.1 A model of economic hedge effectiveness

From an economic perspective hedge effectiveness is generally measured in terms of the amount of risk reduction achieved through the hedging relationship. This typically involves comparing the risk associated with the underlying hedged item against the risk of the portfolio formed by the combination of the underlying and the hedging instrument. The effectiveness result will depend on the risk characteristics of both the underlying hedged item and the hedging instrument, as well as the correlation between them.

Suppose that the relevant performance metric is fair value and that our hedging objective is to reduce the risk associated with changes in fair value over a specified time horizon.

Let U represent the underlying hedged item, H represent the hedging instrument and P represent the portfolio consisting of a combination of both. Then the portfolio is given by:

$$P = U + h \, . \, H \tag{2.1}$$

where h is the 'hedge ratio', that is, the amount of the hedging instrument that is used to hedge the underlying (if h = 1, then we say the hedge is 'one-for-one').

In this example we designate $h.H$ as an economic hedge of U with respect to changes in fair value (i.e., marked-to-market or MTM value) over the specified time horizon. That is we are using h units of the hedging instrument to hedge one unit of the underlying. What is relevant for hedge effectiveness are the changes in fair value, denoted ΔFV, of the underlying, the hedging instrument and the portfolio over the horizon:

$$\Delta FV_P = \Delta FV_U + h \, . \, \Delta FV_H \tag{2.2}$$

We make the assumption that the changes in fair value of the underlying and the hedging instrument are both normally distributed with zero mean, but with different volatilities (or standard deviations) σ_U and σ_H. Then the change in fair value of the portfolio over the horizon will also be normally distributed with a standard deviation σ_P given by:

$$\sigma_P = \sqrt{(\sigma_U^2 + h^2.\sigma_H^2 + 2h.\sigma_U.\sigma_H.\rho)} \tag{2.3}$$

where ρ is the correlation between changes in fair value of the underlying and hedging instrument. Note that for this to make sense as a hedging situation the correlation must be negative.

Now let us assume that the volatility of changes in fair value is the appropriate measure of risk for this situation. (Volatility is a common risk measure, but it is not the only choice). With this measure of risk the selected hedge will be effective (but not necessarily highly effective) if it reduces the risk of the underlying:

$$\text{If } \sigma_P < \sigma_U \text{ then the hedge is effective} \tag{2.4}$$

The degree of effectiveness is given by the *relative risk reduction* of the hedge:

$$RRR = (\sigma_U - \sigma_P) \; / \; \sigma_U \tag{2.5}$$

If $RRR > 0$ then the hedge is effective because it reduces risk relative to the unhedged risk of the underlying.

2.4.2 Optimal hedge effectiveness

Optimal hedge effectiveness corresponds to adjusting the hedge ratio h in equation (2.1) to achieve the lowest risk for the portfolio, or in other words, maximal risk reduction. From equation (2.3) it can be shown that the hedge ratio that provides maximal risk reduction is:

$$h^* = -\rho \, . \, (\sigma_U \; / \; \sigma_H) \tag{2.6}$$

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Note that, since the correlation is negative, the optimal hedge ratio is positive. In this case the risk of the portfolio is given by:

$$\sigma_P^* = \sigma_U \cdot \sqrt{(1 - \rho^2)} \qquad (2.7)$$

and so the optimal risk reduction ratio depends only on the correlation between the underlying and the hedged item:

$$RRR^* = 1 - \sqrt{(1 - \rho^2)} \qquad (2.8)$$

This result is in line with our intuition. If the hedging instrument is a perfect hedge, then it must be perfectly negatively correlated with the underlying. In other words for a perfect hedge the correlation is equal to –1 and the optimal hedge ratio from equation (2.6) is given by the ratio of the risk of the underlying over the risk of the hedging instrument. Furthermore, the relative risk reduction for this optimal hedge given by equation (2.8) is 100%, indicating the complete elimination of the risk in the underlying. Conversely, if the correlation is zero then the optimal hedge ratio is zero and the relative risk reduction is zero. This reflects what is intuitively obvious, namely, that there is no value whatsoever in such a hedging instrument.

Chart 2.1 plots the full relationship between the correlation and the relative risk reduction for the optimal hedge as given in equation (2.8). From the chart it is evident that, for example, a correlation of –0.8 leads to a risk reduction of 40%, while a correlation of –0.9 leads to 56% risk reduction.

2.4.3 Effectiveness of 'one-for-one' hedges (h = 1)

The previous subsection dealt with the case of optimal hedging, for which the hedge ratio is set to maximise the level of risk reduction. Here we consider the case of 'one-for-one' hedging for which the hedge ratio h = 1. It is important to note that 'one-for-one' hedging is not in general the same as optimal hedging and the level of risk reduction will be lower than the maximal risk reduction. However, for most interest-rate hedges the optimal hedge has a hedge ratio which is close to one and is, therefore, essentially also a one-for-one hedge. For example, a euro 100 million bond issue hedged with a euro 100 million interest-rate swap is a one-for-one hedge, which is also an optimal hedge with a correlation close to –1.

Setting the hedge ratio to one in equations (2.3) and (2.5) leads to the result that the relative risk reduction is given by:

$$RRR_{h=1} = 1 - \sqrt{[\,1 + (\sigma_H/\sigma_U)^2 + 2.\rho.(\sigma_H/\sigma_U)\,]} \qquad (2.9)$$

This equation enables us to identify the range of correlations that give effective hedges that satisfy equation (2.4). As already noted, an effective hedge in economic terms corresponds to a relative risk reduction between 0 (not effective) and 1 (perfectly effective). From equation (2.9) it follows that for 'one-for-one' hedging the correlation between the underlying and the hedging instrument must lie in the range:

$$-1 \le \rho < -0.5\,(\sigma_H/\sigma_U) \quad \text{for } h = 1 \qquad (2.10)$$

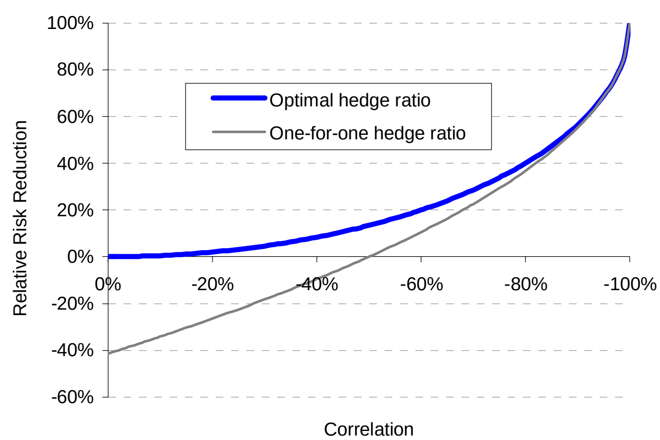
So the correlation must be less than –0.5 multiplied by the ratio of volatilities. This is because a correlation outside this range leads to negative relative risk reduction (i.e., a risk increase).

For the simple case for which the volatilities of the underlying and hedging instruments are equal equations (2.9) and (2.10) become:

$$RRR_{h=1} = 1 - \sqrt{[\,2.(1 + \rho)\,]} \qquad (2.11)$$

$$-1 \le \rho < -0.5 \qquad (2.12)$$

Chart 2.1: How the level of risk reduction varies with the correlation between the underlying and the hedging instrument



Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Equation (2.11) is also plotted in Chart 2.1, and shows a similar level of risk reduction to the optimal hedge for high values of the correlation.

2.4.4 Hedge ratios and hedge effectiveness

The previous two subsections have dealt with special cases for the hedge ratio, namely, the optimal hedge ratio ($h = h^*$) and the one-for-one hedge ratio ($h = 1$). The obvious next question is: what range of hedge ratios leads to effective hedges? From equations (2.3) and (2.5) one can show that positive risk reduction will result for any (negative) correlation provided the hedge ratio falls within the following range:

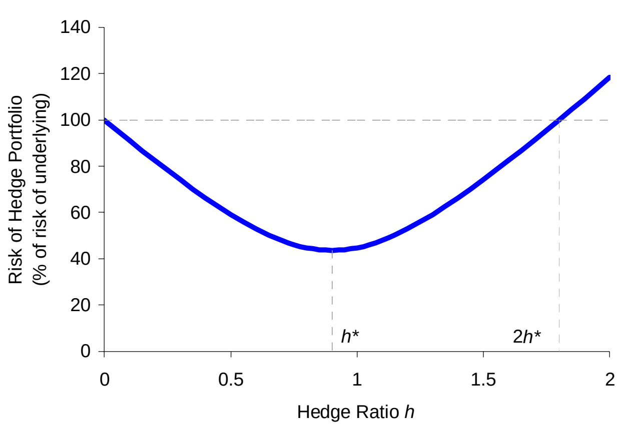
$$0 < h < -2 \,.\, \rho \,.\, (\sigma_U \,/\, \sigma_H) = 2 \,.\, h^* \quad (2.13)$$

So the hedge will be effective providing the hedge ratio is positive and less than twice the size of the optimal hedge ratio defined in equation (2.6). Note that one implication of this equation is that it is possible for a hedge ratio greater than 1 (which is normally considered to be 'over-hedging') to still result in an effective hedge.

The impact of different hedge ratios on overall portfolio risk is shown in Chart 2.2 for the case where the volatilities of the underlying and hedging instrument are equal, and the correlation between them is –0.9. In this case the optimal hedge ratio is $h^* = 0.9$ and the hedge reduces risk as long as the hedge ratio is less than $2h^* = 1.8$.

Chart 2.2: How the risk of the portfolio (underlying + hedging instrument) varies with the hedge ratio

In this example the volatilities are equal $\sigma_U = \sigma_H$ and the correlation is –0.9, so that the optimal hedge ratio is $h^* = 0.9$



2.4.5 Applying this model to cash flow hedges

The above analysis reflects the hedging objective set out in Section 2.4.1, which was to provide protection against changes in the fair value of the underlying. If the hedging objective is not related to fair value but to cash flow, then the above analysis is not appropriate in economic terms. However, it can be made appropriate with a minor change.

First assume that the *changes in cash flow,* denoted ΔCF, of the underlying, the hedging instrument and the portfolio over the horizon are normally distributed. Next assume that these cash flows have volatilities given by σ_U, σ_H and σ_P respectively. Then the relationship between the volatilities is precisely that given in equation (2.3) and the rest of the analysis in Sections 2.4.1 to 2.4.4 remains valid. In particular, equation (2.5) defines the relative risk reduction, equation (2.6) defines the optimal hedge ratio, and equation (2.8) defines the maximal level of cash flow risk reduction.

Note that this approach to cash flow hedge effectiveness is different from the approaches explicitly proposed in the guidance to the accounting standards, which actually discusses several alternative methods. The most widely used method involves evaluating the effectiveness of cash flow hedges in terms of the *changes in fair value* of the hedging instrument relative to those of a 'hypothetical derivative' (essentially the perfect hedge). For further information see Sections 3.1.2 and 3.4.1.

2.4.6 Time horizon for measuring effectiveness

Ideally the time horizon for evaluating hedge effectiveness should match the maturity of the hedging relationship. If hedge effectiveness is evaluated over shorter horizons it is likely to lead to greater ineffectiveness, even for perfect hedges.

However, there are two practical reasons why the time horizon for hedge effectiveness testing is often shorter than the hedging maturity. The first is the need under the accounting standards to measure realised ineffectiveness and test for ongoing effectiveness on regular reporting dates. This means that the appropriate horizon for evaluating hedge effectiveness from an accounting perspective is typically three months or, in some cases, six months, depending on the reporting period and the standard.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

The second reason why the effectiveness time horizon might be shorter than the maturity of the hedge is simply due to lack of appropriate data. Even for quarterly evaluation of effectiveness, the ideal data requirements for a prospective test would need say 60 historical data points involving a quarterly data frequency. This requires 15 years of quarterly data, which may not be available for certain markets, and even if it were available, the fundamental market and economic conditions may have changed so much as to make the early data irrelevant for a forward-looking test. So the need to get adequate, relevant data may lead to an even shorter time horizon than required on reporting grounds. These issues are discussed further later in the document in Section 5.2.3.

2.4.7 Conclusion: Economic metrics of effectiveness

The most common and most intuitive metric for evaluating hedge effectiveness in economic terms is the *relative risk reduction,* or *RRR,* provided by the hedging instrument. This approach is actually being applied to hedge effectiveness testing under the accounting standards and has been discussed in this context by Kalotay and Abreo (2001).

In the foregoing discussion we have described an example of how relative risk reduction is calculated when the appropriate measure of risk is the volatility (standard deviation) of changes in fair value. Although the details will be different, the principles are the same for other measures of risk. For example, Johnson (1960) and Ederington (1979) first addressed hedge effectiveness using as their risk measure the variance (given by the standard deviation squared) of changes in fair value. Other authors, such as Humphreys (2000), have used value-at-risk, or VaR, as the risk measure.

One question remains: How much risk reduction is necessary for a hedge to be considered 'highly effective'? As long as *RRR* is greater than 0, then the hedge should be considered 'effective'. But to be considered 'highly effective' requires a minimal threshold for *RRR* to be defined. One way of doing so is through the correlation. If a minimal correlation of –0.8 is required for a hedging relationship to be highly effective, then from equation (2.8) and Chart 2.1, the minimal risk reduction threshold should be 40%. Alternatively, if a minimal correlation of –0.9 is required, then the minimal risk reduction threshold should be 56%. This is because a correlation of –0.8 is statistically the same as 40% risk reduction, and a correlation of –0.9 is statistically the same as 56% risk reduction.

We further discuss the application of this 'risk reduction' method to hedge effectiveness testing in Sections 4.4.2 and 5.4.3.

2.5 Summary

This chapter has addressed the concept of hedge effectiveness in terms of economic intuition. This intuition ultimately lies behind the accounting standards' perspective of what hedge effectiveness means and how it should be assessed. It is obvious that hedge effectiveness depends on the performance metric being evaluated and the designated risk being hedged. What is less obvious (but will become clear in Chapter 4) is that the result of any hedge effectiveness evaluation is also dependent on how it is implemented. For that reason this chapter has introduced the concept of the 'perfect hedge'. The perfect hedge is 100% effective in terms of eliminating the impact of the designated risk on the chosen performance metric. As such it plays an important role in validating the economic appropriateness of different effectiveness tests and their implementation. If an effectiveness test fails to give perfect, or near-perfect, results for the perfect hedge, then one must question the suitability of the way in which the test has been implemented.

The final section of this chapter has examined the calculation of hedge effectiveness from an economic viewpoint. From this perspective, the most common and intuitive metric for hedge effectiveness is the degree of risk reduction achieved by a hedge. The so-called 'risk reduction' methods for evaluating hedge effectiveness are explained in greater detail in Chapters 4 and 5.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Chapter 3. Principles of hedge effectiveness under IAS 39 and FAS 133

As we have already emphasised, the introduction of IAS 39 and FAS 133 have radically changed the recognition, measurement and reporting of financial derivatives. Because derivatives that do not qualify for hedge accounting can, in some cases, have a significant impact on earnings volatility, it has become important for all corporations to evaluate the effectiveness of such hedges.

In this Section we describe what the standards say (and don't say) about hedge effectiveness. It will be seen that for both standards a key requirement for derivatives to qualify for hedge accounting is a demonstrated minimal level of hedge effectiveness: hedges must be 'highly effective'. However, the standards rightly recognise the need for flexibility in how hedge effectiveness is evaluated. Because different organisations have different risk-management strategies, the imposition of rigid rules would almost certainly have led many corporations to implement inappropriate, inconsistent and ultimately misleading effectiveness tests. This chapter sets out the accounting context for the framework for hedge effectiveness that will be presented in Chapter 5.

3.1 Effectiveness principles and the concept of the 'perfect hedge'

The standards define hedge effectiveness in similar terminology to that used in the above discussion of the economic intuition behind effectiveness. Specifically 'hedge effectiveness' is defined under IAS 39.10 as: 'the *degree to which offsetting changes in fair value or cash flows attributable to a hedged risk are achieved by the hedging instrument'*. FAS 133 defines hedge effectiveness more indirectly in terms of *'...achieving offsetting changes in fair value or offsetting cash flows attributable to the risk being hedged'* (FAS133.62).

These definitions imply that hedge effectiveness assessments should be based on comparison of the hedged item and hedging instrument with respect to a particular *designated risk*.

3.1.1 Derivative hedges must be designated

In general, the standards do not aim to restrict the circumstances in which a derivative may be designated as a hedging instrument, provided that the hedge accounting conditions are met. (The major exception is net written options which can only be designated as hedging instruments where it offsets a mirror purchased option). But the standards do stipulate that the hedging derivative must be formally designated as a hedge at inception. Moreover, it must be designated in its entirety except in two circumstances. The first relates to option hedges for which the time value of the option can be excluded from the hedge designation. In other words, the hedge is provided by the change in the option's intrinsic value only. The second exception involves excluding the interest-rate element on a 'forward hedge' (e.g., a foreign exchange forward contract) from the hedge designation. This means designating the hedge to changes in spot, rather than forward, rates.

By contrast, there is no requirement to designate the hedged item in its entirety. The accounting standards acknowledge that a hedged item's value and/or cash flow are influenced by a variety of specific risk factors. As a result, individual risk factors relating to a hedged item can be designated as the hedged risk, provided that these risk factors can be separately identified and measured.

Where the hedged item is a financial item, IAS 39 requires the corporation to prove that it can isolate and measure the impact of a specific designated risk factor on that hedged item. However FAS 133 details what it considers are the risk factors that can be separately identified and measured for financial hedged items. These are: full fair value or cash flows, benchmark interest rate risk (see Box 3.1), foreign currency risk, obligor's credit risk and change in spread over the benchmark interest rate with respect to the obligor's credit sector (IAS 39.128 and FAS 133.21(f)/29(h)).

Where the hedged item is a non-financial item the designation is limited by both standards to either foreign currency risk or to all risk factors impacting the hedged item (IAS 39.129 and FAS 133.21(e)/29(g)). This restriction is due to what is seen as the greater difficulty of isolating and measuring cash flow and fair value changes attributable to specific risks factors in non-financial items.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

From an accounting viewpoint this designation of the hedged risk in a hedging relationship is a key determinant of hedge effectiveness.

3.1.2 The concept of the 'perfect hedge'

The standards implicitly acknowledge the concept of the 'perfect hedge' described in the previous section. For instance, they outline that where the 'critical terms' of the hedging instrument and hedged item match, the changes in fair value or cash flows attributable to the designated risk will offset fully, both at inception and over the life of the hedging relationship. Whilst the actual wording used in the standards include 'offset fully' and 'completely offset', they are widely understood to mean that, in principle, the hedging instrument is the 'perfect hedge' for the designated risk for accounting purposes. From an accounting perspective this should lead to no ineffectiveness being recognised in earnings over the life of this hedging relationship. (See Box 3.2).

IAS 39 does not specifically define what the 'critical terms' or 'principal terms' are. However, it is reasonable to accept that the terms detailed as examples in different parts of the standard (see e.g., IAS 39.147 – see Box 3.2) constitute the basis for these critical terms. FAS 133's concept of 'critical terms' includes the following: notional amount, repricing dates, floating-rate index, etc. (see e.g., FAS 133 Implementation Issues G7 – Method 2 – see Box 3.2).

In a more practical context, the so-called 'short-cut' method under FAS 133, introduced as an operational accommodation for cash flow and fair value hedges involving interest-rate swaps (see Box 3.3), is consistent with the concept of the intuitive perfect hedge. For hedging relationships which meet the criteria of this method, the standard assumes that the hedge is fully effective and that there is no ineffectiveness recognised in earnings over the life of the relationship. In particular, this method allows one to assume, without on-going assessment of effectiveness, that the change in the fair value of the hedged item with respect to interest-rate risk exactly offsets the change in fair value of the interest rate swap. This clearly fits our intuitive concept of a perfect hedge for the designated risk. (See Section 3.3).

Similarly, the so-called 'matched-term' method for cash flow hedges under FAS 133 (also an operational accommodation) yields a similar result and further substantiates the intuitive 'perfect hedge' concept. Under the 'matched term' method, where the critical terms of the hedging instrument and hedged item match as part of a cash flow hedge, there is no need to undertake any numerical hedge effectiveness test or ineffectiveness measurement. The change in fair value of the hedging instrument is viewed as a proxy for the change in

Box 3.1: Definition of Benchmark interest rate

FAS 133 Appendix F
'A widely recognized and quoted rate in an active financial market that is broadly indicative of the overall level of interest rates attributable to high-credit-quality obligors in that market. It is a rate that is widely used in a given financial market as an underlying basis for determining the interest rates of individual financial instruments and commonly referenced in interest-rate-related transactions.

'In theory, the benchmark rate should be a risk-free rate (that is, it has no risk of default). In some markets, government borrowing rates may serve as a benchmark. In other markets, the benchmark interest rate may be an interbank offered rate. In the United States, currently only the interest rates on direct Treasury obligations of the U.S. government and, for practical reasons, the LIBOR swap rate are considered to be benchmark interest rates. In each financial market, only the one or two most widely used and quoted rates that meet the above criteria may be considered benchmark interest rates.'

Box 3.2: Matching of critical terms

IAS 39.147
'If the principal terms of the hedging instrument and of the entire hedged asset or liability or hedged forecast transaction are the same, the changes in fair value and cash flows attributable to the risk being hedged offset fully, both when the hedge is entered into and thereafter until completion. For instance, an interest rate swap is likely to be an effective hedge if the notional and principal amounts, term, repricing dates, dates of interest and principal receipts and payments, and basis for measuring interest rates are the same for the hedging instrument and the hedged item'.

FAS 133. 65
'If the critical terms of the hedging instrument and of the entire hedged asset or liability (as opposed to selected cash flows) or hedged forecasted transaction are the same, the entity could conclude that changes in fair value or cash flows attributable to the risk being hedged are expected to completely offset at inception and on an ongoing basis.'

FAS 133 Implementation Issues G7 – Method 2
'critical terms ... that is, the same notional amount, same repricing dates, the [floating-rate] index ..., mirror image caps and floors ...'

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

fair value of the hedged item for the designated risk and therefore no earnings volatility will arise (FAS 133 Implementation Issue G9). (See Section 3.3).

A final example of the implicit recognition of the concept of the perfect hedge can be found in the implementation guidance for cash flow hedges under both FAS 133 and IAS 39. This guidance concerns the so-called 'hypothetical derivative method' (known in the IAS 39 implementation guidance as 'Method B: Compute change in the fair value of the cash flows'). This methodology creates a hypothetical derivative hedge against which the actual hedging instrument should be evaluated. This hypothetical derivative fits our intuitive notion of a perfect hedge for the designated risk. (This methodology is discussed further in Section 3.4).

3.1.3 Highly-effective hedges

The accounting standards clearly recognise that a hedging instrument may not always be the perfect hedge of the hedged item in respect of the designated risk. Where a hedging relationship is not perfect, the standards acknowledge that the change in the fair value or cash flows attributable to the hedging instrument may still provide a high level of economic offset with those of the hedged item for the designated risk. For such hedges they agree that this economic offset should be reflected in a corresponding offset within the accounting framework. However the standards set an arbitrary effectiveness threshold for a hedging instrument to qualify for hedge accounting. This arbitrary threshold is determined by the standards' definition of a 'highly effective' hedge. Such a hedge must be expected to achieve this threshold at inception and over the entire life of the hedge. (See Box 3.4).

There is no explicit guidance in FAS 133/138 of what the 'highly effective' threshold level is. However there is a widespread assumption that 80%-125 % is an acceptable range of co-movement in fair value for the hedging instrument and hedged item in order for the hedging relationship to be considered highly effective (see Swad (1995) and FAS 80).

Under IAS 39 there is no explicit guidance on what 'almost fully offset' means for *prospective* effectiveness tests. However it is our understanding that the accounting profession is currently interpreting this as much tighter than the above 80%-125% range, possibly 95%-106%!

Therefore, whilst the standards acknowledge in principle the economic offset of hedging relationships which are not perfect, to obtain hedge accounting and accounting earnings offset the hedge relationship must pass the 'highly effective' threshold. Where the hedge relationship is unable to pass this threshold, no recognition of economic offset will be obtained in earnings. In this situation additional earnings volatility may counter-intuitively be introduced from the initiation of an economic hedge. Corporations generally do

Box 3.3: 'Short-cut' method in FAS 133

FAS133.68 'Assuming no Ineffectiveness in a Hedge with an Interest Rate Swap'
'An entity may assume no ineffectiveness in a hedging relationship of interest rate risk involving a recognized interest-bearing asset or liability and an interest rate swap if all of the applicable conditions . . . are met.'

FAS Implementation Issue G9
'If there are no such changes in the critical terms or adverse developments regarding counterparty default, the entity may conclude that there is no ineffectiveness to be recorded.'

Box 3.4: 'Highly effective' hedges

IAS 39.146
'A hedge is normally regarded as highly effective if, at inception and throughout the life of the hedge, the enterprise can expect changes in the fair value or cash flows of the hedged item to be almost offset by the changes in the fair value or cash flows of the hedging instrument, and actual results are within a range of 80 per cent and 125 per cent. For example, if the loss of the hedging instrument is 120 and the gain on the cash instrument is 100, offset can be measured by 120/100, which is 120 per cent, or by 100/120, which is 83 per cent. The enterprise will conclude that the hedge is highly effective'.

FAS 133.20(b)
'Both at inception of the [fair value] hedge and on an ongoing basis, the hedging relationship is expected to be highly effective in achieving offsetting changes in fair value attributable to the hedged risk during the period that the hedge is designated.'

FAS 133.28(b)
'Both at inception of the [cash flow] hedge and on an ongoing basis, the hedging relationship is expected to be highly effective in achieving offsetting cash flows attributable to the hedged risk during the term of the hedge...'

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

not wish to introduce significant additional earnings volatility through the hedging process. As well as being aware of the existence of this 'highly effective' threshold, it is important to have an appropriate and consistent methodology for assessing hedge effectiveness prior to executing a hedge.

3.2 Assessing hedge effectiveness

The discussion so far has focused on the fact that, in principle, the accounting and economic intuition associated with hedge effectiveness and the concept of the 'perfect hedge' are consistent. Further the standards acknowledge the economic offset of hedging relationships, but only recognise this offset in earnings where the hedging relationship is able to pass the 'highly effective' threshold.

The standards are also clear on the need to assess hedge effectiveness as a prerequisite to allowing any earnings offset from hedge accounting. The standards require an enterprise to assess effectiveness, at a minimum, when it prepares its annual and interim financial reports. FAS 133 stipulates an overriding requirement of assessment at least every three months. Hedge effectiveness requirements are explicitly detailed in IAS 39.142 and FAS 133.20/28 and are:

- To document at inception how the entity will assess hedging instrument effectiveness in offsetting the exposures to changes to the hedged item fair value or hedged transaction cash flows that are attributable to the designated hedged risk.
- To determine that the hedge is expected to be highly effective in achieving offsetting changes in fair value or cash flows attributable to the hedged risk (prospective test).
- To ensure that the effectiveness of the hedge can be reliably measured.
- To assess the hedge on an ongoing basis and determine that the hedge has actually been highly effective throughout the financial reporting period (retrospective test).

Put concisely, there are two key parts to assessing hedge effectiveness under the standards:

- Testing hedge effectiveness: Evaluating whether the hedge relationship is expected to be and actually is 'highly effective' on an on-going basis; and
- Measurement of hedge ineffectiveness: Recognising any hedge ineffectiveness of a qualifying hedging instrument immediately in earnings.

3.3 Methods for testing effectiveness

The standards explicitly detail that there is no single method for assessing hedge effectiveness. When the standards are taken together with the implementation guidance a slightly clearer picture emerges (see Box 3.5). Together they acknowledge that the appropriateness of a given method is dependent on a number of factors, including the risk management strategy, the nature of the designated risk being hedged and the type of hedging instrument being used. They also detail that the effectiveness assessment should be reasonable and consistent across similar hedges unless there is justification for doing otherwise. (See Box 3.5).

The implementation guidance to the standards goes on to outline the use of mathematical techniques to compare the change in value of the hedging instrument and hedged item to the designated risk. These include the mathematically simple 'ratio analysis' in IAS 39 and the related method of 'dollar-offset' in FAS 133, as well as the more complex statistical technique of regression analysis.

Ratio analysis and the dollar-offset approach simply compare the change in fair value of the hedging instrument with that of the hedged item over a period of time, with respect to the designated risk (see Section 5.4.1). The implementation guidance to the standards state that the assessment of hedge effectiveness can be on a period-by-period or on a cumulative basis (IAS 39.142-3 Implementation Guidance and FAS 133 Implementation Issue E8). The implementation guidance to FAS 133 requires that the period-by-period time period can not exceed 3 months and that the cumulative approach involves comparing changes in fair value of hedging instrument and hedged item attributable to the hedged risk from the inception of the hedge.

Regression analysis is a statistical technique used to analyse the relationship between a dependent variable and one or more independent variables (see Section 5.4.2). By taking historical data, regression analysis can be applied to predicting how the dependent variable is expected to change with the independent variable. In assessing hedge effective-

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

ness, the dependent variable would normally be the change in fair value of the hedging instrument and the independent variable the change in fair value of the hedged item. The predictive ability of the dependent variable based on changes in the independent variable can be summarised in terms of three statistics:

- **Correlation**, which measures the degree to which fair value changes in the hedged item and hedging instrument move in opposite directions in response to the designated risk. A perfect hedge should have a correlation of –100%.
- **Slope**, which measures the magnitude of the change in fair value of the hedging instrument relative to that of the hedged item. A perfect hedge should have a slope of –1 for a one-for-one hedge ratio.
- **Intercept** (y-intercept), which measures the expected change in fair value of the hedging instrument when there is no change in the fair value of the hedged item.

In respect of regression analysis (or other statistical analysis), the implementation guidance requires appropriate interpretation and understanding (IAS 39.146-1 Implementation Guidance and FAS 133 Implementation Issue E7 — see Box 3.5). IAS 39 (including the implementation guidance) provides little further direction other than mentioning that these techniques may be used. Where regression analysis is to be used for both prospective evaluation and retrospective consideration, FAS 133 suggests that an entity in general should make use of the same amount of data points for all calculations. Further, it requires the entity to periodically update this analysis to ensure that the expectation of 'high effectiveness' remains even when significant ineffectiveness is measured and recognised in earnings (FAS 133 Implementation Issue E7).

3.3.1 Importance of choosing an appropriate method

Whilst the standards accept that there are potentially a number of alternative appropriate methods an entity can adopt for testing hedge effectiveness, they acknowledge that this choice (which may be different for the prospective consideration and the retrospective evaluation) could affect the ability of a hedging relationship to pass the highly effective threshold over its life. Hence it is extremely important to choose an appropriate and robust method for hedge effectiveness.

Box 3.5: Methods for assessing hedge effectiveness

IAS 39.151
'This standard does not specify a single method for assessing hedge effectiveness'

IAS 39.147
'The method an enterprise adopts for assessing hedge effectiveness will depend on its risk management strategy. In some cases, an enterprise will adopt different methods for different types of hedge'

IAS 39.146-1 Implementation Guidance
'The appropriateness of a given method of assessing hedge effectiveness will depend on the nature of the risk being hedged and the type of hedging instrument being used. The method of assessing effectiveness must be reasonable and consistent with other similar hedges unless different methods are explicitly justified. An enterprise is required to document at the inception of the hedge how effectiveness will be assessed and then apply that effectiveness test on a consistent basis for the duration of the hedge'

IAS 39.142(b), (e)
'the hedge is expected to be highly effective in achieving offsetting changes in fair value or cash flows attributable to the hedged risk, consistent with the originally documented risk management strategy for that particular hedging relationship;
...
'the hedge was assessed on an ongoing basis and determined actually to have been highly effective throughout the financial reporting period.'

FAS 133.62
'this statement does not specify a single method for either assessing whether a hedge is expected to be highly effective or measuring hedge ineffectiveness. The appropriateness of a given method of assessing hedge effectiveness can depend on the nature of the risk being hedged and the type of hedging instrument used. Ordinarily, however, an entity should assess effectiveness for similar hedges in a similar manner; use of different methods for similar hedges should be justified.'

FAS 133 Implementation Issue E7
'Statement 133 requires an entity to consider hedge effectiveness in two different ways – in prospective considerations and retrospective evaluations.
(a) Prospective considerations – Upon designation of a hedging relationship (as well as on an on going basis), the entity must be able to justify an expectation that the relationship will be highly effective over future periods in achieving offsetting changes in fair value or cash flows…
(b) Retrospective evaluations – At least quarterly, the hedging entity must determine whether the hedging relationship has been highly effective in having achieved offsetting changes in fair value or cash flows through the date of the periodic assessment'

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Even though a hedge may not be expected to be 'highly effective' for the current reporting period, hedge accounting will not necessarily be precluded. This is because the hedging relationship may still be expected to pass the 'highly effective' test going forward. (IAS 39.142-3 Implementation Guidance and FAS 133 Implementation Issue E7 — See Box 3.6).

For example, the hedging relationship may retrospectively fail the 'highly effective' threshold test under a dollar-offset approach, but under a prospective regression analysis the hedging relationship may still be expected to be 'highly effective'. As such hedge accounting would not be applied for the current reporting period but may continue to be available for future reporting periods, provided there is continued support for the prospective effectiveness test.

The standards are clear that if the hedging relationship is not expected to be highly effective at any point then hedge accounting must be stopped.

Box 3.6: Issues relating to hedge effectiveness method choice

IAS 39.142-3 Implementation Guidance
'even if a hedge is not expected to be highly effective in a particular period, hedge accounting is not precluded if effectiveness is expected to remain sufficiently high over the life of the hedging relationship.'

FAS 133 Implementation Issue E7
'Electing to utilize a regression or other statistical analysis approach instead of a dollar-offset approach to perform retrospective evaluations of assessing hedge effectiveness may affect whether an entity can apply hedge accounting for the current assessment period…'

IAS 39.156/163 for a Fair value Hedge/Cash Flow Hedge
'An enterprise should discontinue prospectively the hedge accounting… if… (b) the hedge no longer meets the criteria for qualification for hedge accounting in paragraph 142'

FAS 133.67
'If the hedge fails the effectiveness test at any time (that is, if the entity does not expect the hedge to be highly effective at achieving offsetting changes in fair value or cash flows), the hedge ceases to qualify for hedge accounting.'

FAS Implementation Issue E7
' ...in its retrospective evaluation, an entity might conclude that, under a dollar-offset approach, a designated hedging relationship does not qualify for hedge accounting for the period just ended, but that the hedging relationship may continue because, under a regression analysis approach, there is an expectation that the relationship will be highly effective in achieving offsetting changes in fair value or cash flows in future periods.'

3.3.2 Short-cut and matched-term methods under FAS 133

Although there is a general requirement to mathematically assess hedge effectiveness, there are exceptions under FAS 133. The two specific instances, which were both introduced as operational accommodations, are the 'matched-term' method for cash flow hedges and the 'short-cut' method for cash flow and fair value hedging relationships where an interest-rate swap is the hedging instrument. As outlined previously, hedging instruments that meet these criteria would be considered intuitively perfect hedges.

Under the 'matched-term' method, where the critical terms of the hedging instrument and hedged item match as part of a cash flow hedge, there is no need to undertake any numerical hedge effectiveness test or ineffectiveness measurement. This is providing the critical terms (and the credit risk of the derivative counterparty) are formally reviewed over the life of the hedge to ensure there have been no changes. In this situation, the change in fair value of the hedging instrument is viewed as a proxy for the change in fair value of the hedged item for the designated risk and therefore no earnings volatility will arise (FAS 133 Implementation Issue G9).

The 'short-cut' method can be used under certain conditions when an interest-rate swap is hedging the interest-rate risk of an interest-bearing asset or liability. The conditions include the requirement that all critical terms match and that the fair-value of the swap at inception is zero (FAS 133.68). This method allows one to assume, without on-going assessment of effectiveness, that the change in the fair value of the hedged item with respect to interest-rate risk exactly offsets the change in fair value of the interest rate swap. Hence there will be no earnings ineffectiveness for accounting purposes. (See Box 3.3).

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

3.4 Ineffectiveness measurement and recognition

As already emphasised, the standards distinguish between effectiveness testing and ineffectiveness measurement. The latter involves evaluating the realised amount of ineffectiveness in a given accounting period.

Let us assume that a hedging relationship has passed the 'highly effective' test based on an appropriate hedge effectiveness methodology. Apart from the limited circumstances under FAS 133 noted in the previous section ('matched-term' method and 'short-cut' method), ineffectiveness must be measured in absolute amount and recognised in earnings immediately. This is true whether the hedge relationship is considered to be a fair value hedge, cash flow hedge or a hedge of a net investment in a foreign entity (IAS 39.153/158/164 and FAS 133.22/30/42).

Under cash flow hedge accounting, ineffectiveness is only recognised when there is an *'over-hedge'*, that is when the change in fair value of the derivative is *greater* than that of the hedged item. For 'under-hedges', for which the change in fair value of the derivative is less than that of the hedged item, there is no entry to earnings so long as the relationship is highly effective.

As for effectiveness testing the standards do not specify a single method for ineffectiveness measurement. However FAS 133 explicitly states that the measurement of hedge ineffectiveness for fair value hedges should be consistent with the entity's risk management strategy and the method for testing hedge effectiveness documented at hedge inception (FAS 133.22). Implicitly this consistency requirement applies to all other types of hedges under FAS 133, and the spirit of IAS 39 echoes this requirement.

FAS 133 also requires that, for fair value interest-rate hedges, the measurement methodology chosen must include all contractual cash flows of the entire hedged item in calculating fair value (FAS 133.21(f)). For example, the coupon component corresponding to credit risk must be included along with the coupon component relating to the benchmark interest rate (see Box 3.7). Note that this does not apply to cash flow hedges.

In terms of the recognition of ineffectiveness both standards are clear. The amount of ineffectiveness to be recognised to earnings should be based on the extent to which exact offset is not achieved and this should be recognised immediately. (See Box 3.8).

Therefore, whilst the effectiveness test determines whether hedge accounting is permitted, the exact lack of offset in the current reporting period between the change in fair value of the hedging instrument and hedged item for the designated

Box 3.7: FAS 133 requires all contractual cash flows

FAS 133.21f
'In calculating the change in the hedged item's fair value attributable to changes in the benchmark interest rate, the estimated cash flows used in calculating fair value must be based on all of the contractual cash flows of the entire hedged item. Excluding some of the hedged item's contractual cash flows (for example, the portion of the interest coupon in excess of the benchmark interest rate) from the calculation is not permitted'.

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'. . . excluding the hedged item's contractual cash flows would introduce a new approach to bifurcation of a hedged item that does not currently exist in the Statement 133 hedging model'.

Box 3.8: Impact of ineffectiveness on earnings

FAS 133.22
'The measurement of hedge ineffectiveness for a particular hedging relationship shall be consistent with the entity's risk management strategy and the method of assessing hedge effectiveness that was documented at the inception of the hedging relationship... Nevertheless, the amount of hedge ineffectiveness recognized in earnings is based on the extent to which exact offset is not achieved.'

FAS 133 Implementation Guidance E7
'In all instances, the actual measurement of hedge ineffectiveness to be recognized in earnings each reporting period is based on the extent to which exact offset is not achieved ....That requirement applies even if a regression or other statistical analysis approach for both prospective considerations and retrospective evaluations of assessing effectiveness supports an expectation that the hedging relationship will be highly effective and demonstrates that it has been highly effective, respectively'

IAS 39.158(b)
'...the ineffective portion should be reported....immediately in net profit or loss if the hedging instrument is a derivative.'

IAS 39 Implementation Guidance 142-3
'...any ineffectiveness is required to be recognised in earnings as it occurs.'

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

risk determines the actual ineffectiveness recognised in earnings. This is essentially the dollar-offset method discussed above, but applied to just one period.

3.4.1 Measuring ineffectiveness for cash flow hedges of interest-rate risk

The implementation guidance to both standards provide some specific suggestions for ineffectiveness measurement for cash flow hedges. Two methods are discussed in the IAS 39 implementation guidance: 'Method A: Compute change in fair value of debt'; and 'Method B: Compute change in fair value of cash flows' (IAS 39 Implementation Guidance 158-4). By contrast FAS 133 discusses three methods: 'Method 3: change in fair value method' (equivalent to IAS 39 Method A); 'Method 2: hypothetical derivative method' (equivalent to IAS 39 Method B); and Method 1: change in variable cash flows method (FAS 133 Implementation Issue G7).

The most significant methodology is likely to be IAS 39 Method B, which is equivalent to FAS 133 Method 2 (the 'hypothetical derivative' method). In this method the hedged item for, say, a cash flow hedge of interest-rate risk is represented by a hypothetical interest-rate swap whose floating leg has identical critical terms to those of the hedged item. The standards explicitly state that the hypothetical swap is 'expected to perfectly offset the hedged cash flows'. The ineffectiveness measurement is based on comparison of the cumulative change in fair value of this perfectly effective hypothetical derivative to the cumulative change in fair value of the actual derivative. (See Box 3.9).

3.5 Summary

IAS 39 and FAS 133 both implicitly acknowledge the concept of the 'perfect hedge' and recognise that such hedges should provide complete offset with respect to changes in the underlying hedged item due to the designated risk. They also acknowledge that the perfect hedge should not give rise to any measured ineffectiveness in principle.

Box 3.9: The 'hypothetical derivative' method for cash flow hedges

FAS 133 Implementation Issues G7
'the measurement of hedge ineffectiveness may be based on a comparison of the change in fair value of the actual swap designated as the hedging instrument and the change in fair value of a hypothetical swap... That hypothetical swap would have terms that identically match the critical terms of the floating-rate asset or liability (that is, the same notional amount, same repricing dates, the index on which the hypothetical swap's variable rate is based matching the index on which the asset or liability's variable rate is based, mirror image caps and floors, and a zero fair value at inception of the hedging relationship...) Thus, the hypothetical swap would be expected to perfectly offset the hedged cash flows. The change in the fair value of the "perfect" hypothetical swap can be regarded as a proxy for the present value of the cumulative change in expected future cash flows on the hedged transaction...'

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'This method also could be referred to as the "theoretical swap" method (or "hypothetical derivative" method) because the comparison is between the fixed rate on the debt and the current variable rate, which is the same as comparing cash flows on the fixed and variable rate legs of an interest rate swap.'

No single method for assessing hedge effectiveness is prescribed by the standards. Except in limited circumstances (e.g., the 'matched term' and 'short-cut' methods under FAS 133), an appropriate, consistent methodology should be used for hedge effectiveness testing and ineffectiveness measurement.

Whatever the chosen method, the ineffectiveness recognised in earnings should be the exact lack of offset between the hedging instrument and hedged item for the designated risk over the current reporting period.

In the next section, we explore some of the practical issues connected with the implementation of hedge effectiveness methodologies. Through detailed examples we illustrate some of the pitfalls associated with inappropriate effectiveness methodologies. These pitfalls are particularly evident for fair value hedges of interest-rate risk.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Chapter 4. Practical issues surrounding hedge effectiveness testing

This chapter is concerned with the reconciliation of the intuition behind hedge effectiveness and its practical implementation under FAS 133 and IAS 39. The best way to do this is through some simple examples. In particular, we evaluate hedge effectiveness of the intuitively 'perfect' fair value hedge for the interest-rate risk on a fixed-rate bond in different situations. By applying the common interpretation of the effectiveness testing guidelines to such a perfect hedge, we demonstrate the potential pitfalls of hedge effectiveness testing.

The three examples we use are all based on historical data over the period 1997 to 2002. These examples involve by their very nature a retrospective test of hedge effectiveness, but they have important implications for prospective testing. In each example, the underlying hedged item is a five-year fixed-rate bond issued in March 1997, which is hedged by a

Table 4.1: The details of the underlying hedged item and hedging instrument in Example 1

	Underlying Hedged Item	Hedging Instrument	
	Fixed-Rate Bond	**Interest-Rate Swap**	
Notional	GBP 100 mm	GBP 100 mm	
Settlement date	5 March 1997	5 March 1997	
Maturity date	5 March 2002	5 March 2002	
Price at Settlement	100	0	
Coupon	Fixed Rate 7.29%	Receive: Fixed Rate 7.29%	Pay: 6 month Libor[1]
Coupon frequency	Semi-annual on 5 Mar and 5 Sep	Semi-annual on 5 Mar and 5 Sep	Semi-annual on 5 Mar and 5 Sep
Credit spread over swaps	Zero	Zero	Zero

Table 4.2: The details of the underlying hedged item and hedging instrument in Example 2

	Underlying Hedged Item	Hedging Instrument	
	Fixed-Rate Bond	**Interest-Rate Swap**	
Notional	EUR 100 mm[1]	EUR 100 mm[1]	
Settlement date	5 March 1997	5 March 1997	
Maturity date	5 March 2002	5 March 2002	
Price at Settlement	100	0	
Coupon	Fixed Rate 4.75%	Receive: Fixed Rate 4.75%	Pay: 6 month Libor
Coupon frequency	Annual on 5 Mar	Annual on 5 Mar	Semi-annual on 5 Mar and 5 Sep
Credit spread over swaps	Zero	Zero	Zero

Table 4.3: The details of the underlying hedged item and hedging instrument in Example 3

	Underlying Hedged Item	Hedging Instrument	
	Fixed-Rate Bond	**Interest-Rate Swap**	
Notional	EUR 100 mm[1]	EUR 100 mm[1]	
Settlement date	5 March 1997	5 March 1997	
Maturity date	5 March 2002	5 March 2002	
Price at Settlement	100	0	
Coupon	Fixed Rate 6.75%	Receive: Fixed Rate 6.75%	Pay: 6 month Libor
Coupon frequency	Annual on 5 Mar	Annual on 5 Mar	Semi-annual on 5 Mar and 5 Sep
Credit spread over swaps	+200bps	+200bps	+195bps

[1] *Prior January 1, 1999 DEM data was used instead of EUR*

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

five-year interest-rate swap, in which the corporation pays floating rate and receives a fixed rate. (See Tables 4.1 to 4.3). The hedging objective is to hedge changes in fair value due to changes in the benchmark interest rate, in particular, the swap rate. So, we exclude from the effectiveness test changes in fair value related to changing credit quality of the issuing entity by keeping the credit spread constant. Hedge effectiveness is evaluated using the realised historical swap rates, with standard market conventions for both the hedging instruments and the hedged item. The first effectiveness test we use is based on regression analysis, with effectiveness thresholds of –80% for the correlation and –0.80 to –1.25 for the slope. These regression tests are discussed in Sections 4.1-4.3. Other types of test, such as the dollar-offset method and risk reduction method, can yield very different results as we shall see in Section 4.4.

The first example involves a corporation issuing a bond at the flat swap rate, i.e., without credit spread. This is hedged with an interest-rate swap for which the fixed and floating legs have the same payment frequencies. In the second example, we look at the influence on hedge effectiveness of differing payment frequencies on the two swap legs. We again consider the underlying to be a fixed-rate bond issued at the flat swap rate. The third example evaluates the impact of a non-zero credit spread on the hedge effectiveness test.

In all these cases the swaps are intuitively perfect hedges. Moreover, the criteria for the matching of all critical terms under IAS 39 are met and the hedges are eligible for 'short-cut' treatment under FAS133. Hence, consistent with our intuition, both accounting standards would, in principle, consider these swaps perfect hedges.

Despite this, effectiveness tests show significant ineffectiveness if they are implemented using common interpretations of the implementation guidance. (See Tables 4.4-4.6).

4.1 Example 1: The 'perfect' fair value interest-rate hedge for a bond

In this first example, the underlying hedged item is a five-year bullet bond in Sterling paying a semi-annual fixed-rate coupon. The bond has standard market conventions and is issued at the five-year swap rate, without credit spread. The hedging instrument is a fair value hedge of the interest-rate risk on the bond, using a plain vanilla interest-rate swap with

Table 4.4: The results of regression effectiveness tests for Example 1

Underlying Hedged Item: 5-year GBP fixed-rate bond (debt) paying 7.29% semiannual
Hedging Instrument: 5-year GBP interest-rate swap receive 7.29% semiannual, pay 6-month Libor semiannual
Hedging Objective: To hedge changes in fair value due to changes in the benchmark interest rate (swap rate)
Effectiveness Test: Cumulative change in fair value from inception with fair value calculated as either MTM value or clean price value

Test	Underlying	Hedge	Correlation	Slope
1.	MTM	MTM	–86%	–0.68
2.	Clean Price	MTM	–98%	–0.93
3.	Clean Price	Clean Price	–99.99%	–1.01

Table 4.5: The results of regression effectiveness tests for Example 2

Underlying Hedged Item: 5-year EUR fixed-rate bond (debt) paying 4.75% annual
Hedging Instrument: 5-year EUR interest-rate swap receive 4.75% annual, pay 6-month Libor semiannual
Hedging Objective: To hedge changes in fair value due to changes in the benchmark interest rate (swap rate)
Effectiveness Test: Cumulative change in fair value from inception with fair value calculated as either MTM value or clean price value

Test	Underlying	Hedge	Correlation	Slope
1.	MTM	MTM	–96%	–0.92
2.	Clean Price	MTM	–81%	–1.04
3.	Clean Price	Clean Price	–99.99%	–1.01

Table 4.6: The results of regression effectiveness tests for Example 3

Underlying Hedged Item: 5-year EUR fixed-rate bond (debt) paying 6.75% annual
Hedging Instrument: 5-year EUR interest-rate swap receive 6.75% annual, pay 6-month Libor + 195bp semiannual
Hedging Objective: To hedge changes in fair value due to changes in the benchmark interest rate (swap rate)
Effectiveness Test: Cumulative change in fair value from inception with fair value calculated as either MTM value or clean price value

Test	Underlying*	Hedge	Correlation	Slope
1.	MTM	MTM	–94%	–0.89
2.	Clean Price	MTM	–71%	–1.11
3.	Clean Price	Clean Price	–99.99%	–1.06

* *The underlying is valued off the swap curve + 200 bp, the latter being the credit spread for this issuer at the time of issuance.*

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

the same maturity, same notional, same fixed-rate payment dates and same fixed-rate coupon as the bond. So the fixed-rate leg of the swap exactly matches that of the bond. The floating-rate leg of the swap has a regular refixing of the floating interest rate semi-annually. The convention for a standard GBP swap is a semi-annual payment frequency on both legs of the swap. These details are all summarized in Table 4.1.

As mentioned above, intuitively this swap should constitute the perfect fair value hedge of the bond. (Moreover, it qualifies for shortcut treatment under FAS133 so that effectiveness does not have to be explicitly tested.)

To test the effectiveness of the swap hedge, we have evaluated the marked-to-market (MTM) values of the bond and the swap over the life of the transaction, taking account only of changes in the benchmark interest rate (i.e., the swap rate). The valuations have been performed weekly using the actual historical swap curve on each valuation day along with standard market pricing conventions. At each valuation date, we have calculated the change in the MTM value of both the bond and the swap from inception of the hedge (i.e., the cumulative change). These cumulative changes are shown in Chart 4.1.

Comparing the cumulative changes in MTM value of the swap with that of the bond, Chart 4.1 shows that there are significant mismatches. In particular, the change in value of the bond tends to be more extreme than that of the swap, with the largest mismatches occurring at regular time intervals. We have quantified the degree of mismatch by performing a hedge effectiveness test using regression analysis. The results of this test over the entire five-year period reveal a correlation of –86% with a slope of –0.68 (see Chart 4.2).

It is important to note that this result for the slope would make the conclusion that this hedge was highly-effective questionable, since the threshold we defined above was 0.80-1.25. A perfect hedge should have a correlation of –100% and a slope of –1.00. *Hence, we have the paradoxical situation of a 'perfect' hedge failing the effectiveness test.*

Why does this 'perfect' hedge fail? The answer lies in the mismatch in the accrued interest between the swap and the bond. By comparing the MTM value of the bond with that of

Results for the 'perfect' fair value interest rate hedge in Example 1.

Chart 4.1: Cumulative change in MTM value of the bond vs. MTM value of the swap

% of notional

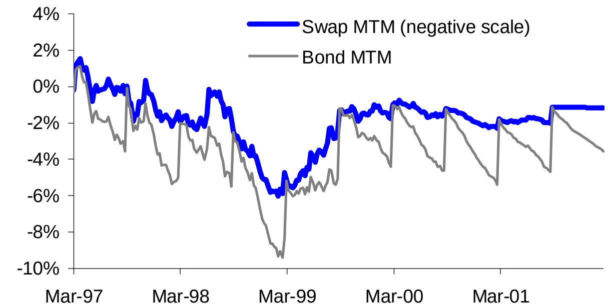


Chart 4.2: Scatter chart of cumulative change in MTM value of the bond vs. MTM value of the swap

% of notional

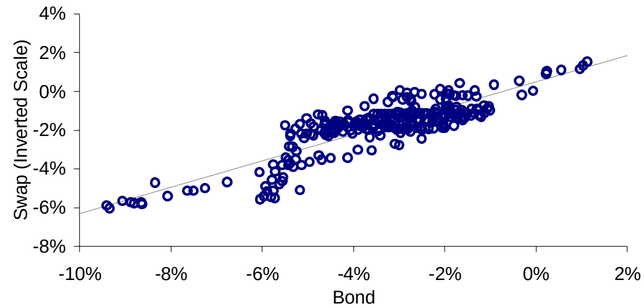


Chart 4.3: Cumulative change in MTM value of the swap vs. clean price of the bond

% of notional

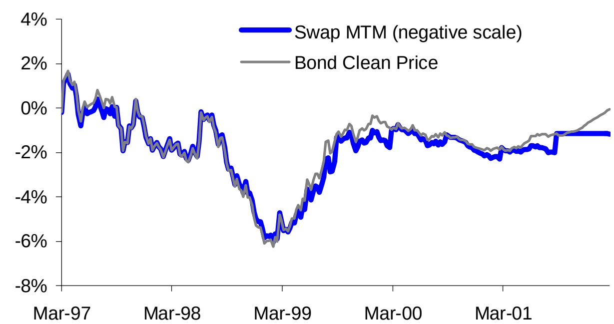
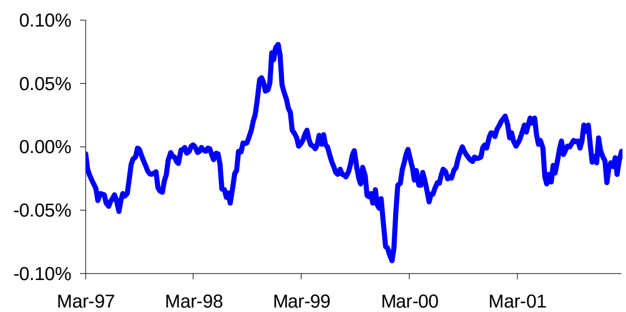


Chart 4.4: Cumulative change in clean price of the bond minus cumulative change in clean price of the swap

% of notional



Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

the swap, we are including the accrued interest of both instruments. For the swap the accrued interest of its two legs partially offset each other, leading to the total accrued interest for the swap being much smaller than that of the bond.

One obvious potential resolution to this paradox is to exclude the accrued interest on the bond from its fair value, i.e., use the so-called 'clean price' value. If we compare the changes in MTM value of the swap with the changes in the 'clean price' of the bond, the magnitude of this problem is reduced significantly. The results of the regression test over the five-year period now give a correlation of –98% with a slope of –0.93 (see Chart 4.3).

Using the clean price value for the bond gives an effectiveness result which is clearly better. Most people would agree that this result demonstrates that the 'perfect hedge' passes the 'highly effective' test. However, there are three important points to note:

- The above increase in effectiveness when using the clean price of the bond, rather than the marked-to-market value, does not always hold.
- It is inconsistent and inelegant to treat the accrued interest on the bond and the accrued interest on the swap differently.
- Even using the clean price of the bond we still get some ineffectiveness in the 'perfect hedge'.

Hence, we have not satisfactorily resolved the paradox. Our next attempt to do so involves removing the accrued interest from both the bond and the swap. Chart 4.4 compares the clean price of the bond against the 'clean price' value of the swap. (We define the clean price value of the swap to be the marked-to-market value of the swap with the contribution of the accrued interest on both legs of the swap removed). The results of the regression test are almost —but not quite— perfect with a correlation of –99.99% and a slope of –1.01. So the 'perfect hedge' is again 'highly effective', but still shows a small ineffectiveness.

This ineffectiveness can be understood as follows. The fixed leg of the swap exactly matches the bond in all its terms and cash flows (apart from the cash flows being in opposite directions). There is therefore perfect offset between the bond and the fixed leg of the swap in terms of changes in MTM value. So any ineffectiveness is due to changes in the MTM value of the swap's floating leg. Although the value of the floating leg is always close to par, it is not exactly par. This is due to the next floating-rate coupon having been fixed at a rate which is in general different from the prevailing discount rate for that coupon. In other words, this residual ineffectiveness is due to the fact that between floating coupon reset dates the value of the floating leg of the swap fluctuates away from par, even in terms of clean price value.

The results of the three different ways of comparing the fair value of the bond with that of the swap are summarised in Table 4.4.

In summary Example 1 has shown two important lessons. First, *accrued interest can produce spurious ineffectiveness results* under many of the common implementations of hedge effectiveness testing. Second, excluding accrued interest from the effectiveness test provides better results, but *even a perfect hedge can show ineffectiveness* under these implementations. These results suggest that the most common implementations of hedge effectiveness testing are economically flawed, contradicting both our intuition and the accounting standards' implicit concept of the 'perfect hedge' (see the discussion in Section 3.1).

4.2 Example 2: The 'perfect' fair value interest-rate hedge with payment frequency mismatches

The situation described in Example 1 above gets more complicated if the swap does not have the same payment frequency on each of its legs. In the EUR market the convention is to issue bonds with fixed-rate coupons which are paid annually, and if appropriate to swap these bonds into 6-month Libor paid semi-annually. Hence the most common EUR interest-rate swap is one for which a bond issuer receives a fixed coupon annually and pays a floating coupon semi-annually.

Consider the example of a European issuer wishing to hedge a five-year EUR-denominated bond paying an annual fixed-rate coupon. Again it is assumed that the issuer has a credit spread equivalent to the swap curve so that the bond is issued at the flat five-year swap rate. The issuer wishes to put on a fair value interest-rate hedge using a plain vanilla

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

interest-rate swap with all payment terms on the fixed leg matching those of the bond. As in the previous example, this swap intuitively constitutes the perfect fair value hedge of the bond (and also qualifies for short-cut treatment under FAS 133). The details of the bond and swap are shown in Table 4.2.

For this example, we again evaluate hedge effectiveness in three ways by comparing the cumulative changes in the bond and the swap in terms of:

- MTM value of bond vs. MTM value of swap
- Clean price value of bond vs. MTM value of swap
- Clean price value of bond vs. clean price value of swap

The results are in line with what might be expected having examined Example 1 above (see Table 4.5).

In particular, Charts 4.5 and 4.6 show the results for the first of these comparisons, where the fair value of both instruments is measured in terms of MTM value. The measured correlation is –96% and the slope is –0.92.

The results of the second way of comparing the bond and the swap yield a correlation of –81%. This suggests that effectiveness is marginal under FAS 133, despite being eligible for short-cut treatment. However, it would be expected to fail tighter thresholds, which are currently being put forward under IAS 39. All this is despite the swap being the intuitively perfect fair value hedge for the interest-rate risk on the bond. The mismatch of the payment frequency causes the total accrued interest of the swap to oscillate due to each floating coupon being split between two payment dates. This causes the correlation between the MTM changes of the swap and the clean price value changes of the bond to break down (see Chart 4.5).

The third method comparing the clean price values of both the swap and the bond gives significantly better results. In this case the swap is 'highly effective', but it still shows a small degree of ineffectiveness. As in Example 1 this ineffectiveness is due to the next floating-rate coupon on the swap being fixed at a rate which is in general different from the prevailing discount rate for that coupon (they are only equal on the reset, or fixing, date).

Results for the 'perfect' fair value interest rate hedge in Example 2, where fixed and floating swap legs have payment frequency mismatches.

Chart 4.5: Cumulative change in MTM value of swap vs. MTM value of the bond

% of notional

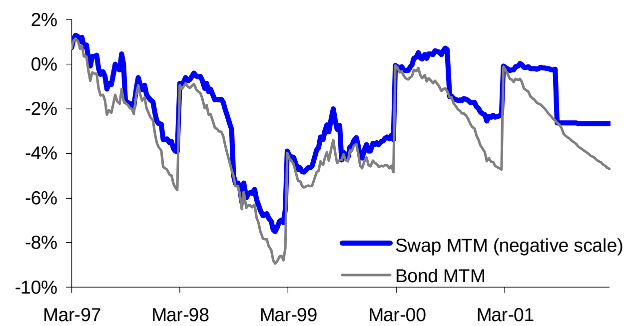
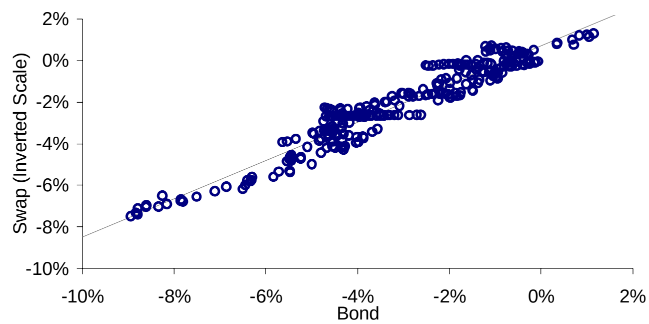


Chart 4.6: Scatter chart of cumulative change in MTM of swap vs. MTM of the bond

% of notional



In summary, this example illustrates that differing payment frequencies for the two swap legs can exacerbate the problems already discussed in Example 1.

4.3 Example 3: The 'perfect' fair value interest-rate hedge with issuer credit spread

In this third example, we consider a bond which has a non-zero credit spread at issuance. We demonstrate that an overly simplistic treatment of credit spread can lead to further inconsistencies relating to hedge effectiveness.

The underlying hedged item is again a bullet five-year EUR bond paying an annual fixed-rate coupon. We assume that the bond issuer has a credit rating which leads to an issuance spread of 200bp over the swap curve. The hedge under consideration is again a fair value hedge of the interest rate

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

risk on the bond. The hedging instrument is a plain vanilla interest-rate swap with a matching fixed-rate coupon, a floating-rate coupon of Euribor + 195bp (to make the swap zero valued), and all other terms matching. This is exactly the same as Example 2, except for the credit spreads on the bond and swap. These details are summarized in Table 4.3.

For this example we again evaluate hedge effectiveness in the same three ways (see Table 4.6) by comparing the cumulative changes in the bond and the swap in terms of:

- MTM value of bond vs. MTM value of swap,
- Clean price value of bond vs. MTM value of swap,
- Clean price value of bond vs. clean price value of swap.

In addition to the decision of how to treat accrued interest, in this example we also face the decision of how to treat the credit spread on the bond in computing its fair value. The three obvious alternatives which are widely discussed in this context are:

1. Price the bond using the swap curve plus the fixed credit spread
2. Price the bond using the swap curve flat (i.e., with no credit spread)
3. Price the bond using the swap curve flat, but exclude all cash flows corresponding to the credit spread (i.e., exclude those cash flows unrelated to the designated risk)

Given the requirement under FAS 133 to use 'all contractual cash flows' (FAS 133.21(f)), it is our understanding that alternative 3 is not in principle permitted under US GAAP. However, this method is not explicitly ruled out under IAS 39 and it is our current understanding that this is a potentially appropriate methodology for this standard.

We now evaluate the first two alternatives for treatment of credit spread and show that neither approach is ideal. The third alternative essentially involves ignoring the credit spread and gives identical results to those discussed in Example 2.

4.3.1 Pricing the bond off the swap curve plus spread

Chart 4.7 shows the cumulative change in the MTM value of the bond and that of the swap, when the bond is priced using the swap curve + 200 bp credit spread. In this case regression analysis yields a correlation of –94% and a slope of –0.89, which correspond to a lower level of effectiveness than in Example 2 (–96% and –0.92). For the comparison between the cumulative change in the clean price of the swap and the clean price of the bond the correlation is –99.99% and the slope –1.06, which again reflects lower effectiveness than in Example 2 (–99.99% and –1.01).

Note that in this case the change in fair value of the fixed leg of the swap no longer offsets that of the bond, despite their cash flows being identical. This is because the swap is valued using the swap curve flat, i.e., without a spread, and the bond is valued with the spread. This leads to residual ineffectiveness even for this perfect hedge.

Results for the 'perfect' fair value interest rate hedge in Example 3, where the bond has a credit spread of +200 bp over the swap curve.

Chart 4.7: Cumulative change in MTM value of swap vs. MTM value of the bond. Bond priced using swaps + 200 bp

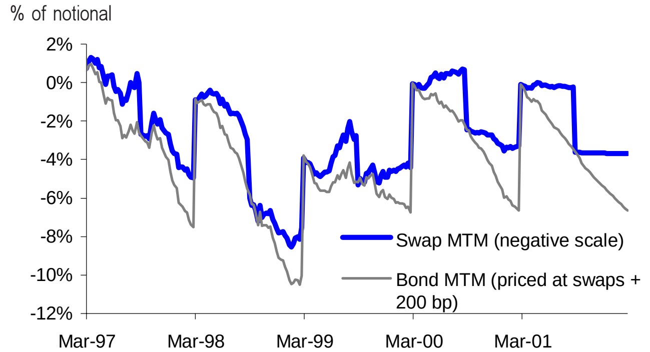
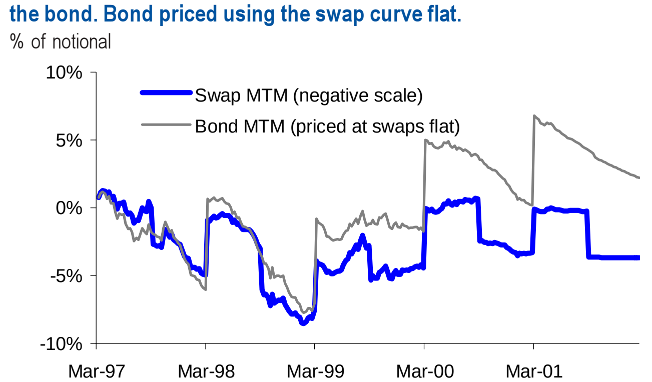


Chart 4.8: Cumulative change in MTM value of swap vs. MTM value of the bond. Bond priced using the swap curve flat.



Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

4.3.2 Pricing the bond off the swap curve flat

Chart 4.8 shows the cumulative change in the MTM value of the bond and that of the swap, when both are priced using the swap curve without any credit spread. In this case regression analysis yields a correlation of –70% and a slope of –0.48, which cannot considered to be effective. For the comparison between the cumulative change in the clean price of the swap and the clean price of the bond the correlation is –61% and the slope –0.31, which is even worse.

The choice of how to price the bond clearly impacts the results of the effectiveness tests. If we use the swap curve without any spread, then the initial valuation of the bond used to compute changes in fair value for hedge effectiveness is not par but 108.83, since the bond coupon is so much larger than the discount rate. This initial variance from par will create a drift factor in the change in fair value compared to a bond whose initial valuation is par. This will lead to additional ineffectiveness.

4.3.3 Pricing the bond excluding credit-spread cash flow

This alternative essentially removes the credit spread from the effectiveness calculation. The argument for doing so is that we are hedging changes in fair value due to changes in the benchmark interest rate (i.e., the swap rate), and not those due to changes in credit spread. This approach reduces the effectiveness test to the case of zero credit spread as in Example 2. But as we have already mentioned, it is our understanding that this approach is not in principle permitted under FAS 133 (FAS 133.21f — see Box 3.7), although it is not ruled out under IAS 39.

4.3.4 Conclusions: Treatment of credit spread

In the first two alternatives for computing changes in fair value, the level of effectiveness is reduced relative to Example 2 solely because of the non-zero credit spread. Yet the swap is still intuitively the perfect fair value interest-rate hedge. Of these two alternatives, the first is the most acceptable, i.e., evaluating changes in fair value with a constant credit spread on the bond. The third alternative for treating the credit spread is the only one that gives completely intuitive results.

4.4 Results of different types of effectiveness tests

In this section we discuss the results of applying different types of effectiveness tests to the same three examples evaluated in Sections 4.1 to 4.3. Following the regression analyses presented above, we now evaluate hedge effectiveness based on the dollar-offset method and the risk reduction method. These tests confirm the results of the previous regression tests, namely that accrued interest and credit spreads lead to reduced effectiveness.

4.4.1 Applying the dollar-offset test

This sub-section describes the results of applying the dollar-offset test to the three hedging examples. The dollar-offset test involves the following method. Every week over the life of hedge calculate the dollar-offset ratio, which is given by the cumulative change in fair value of the hedging instrument divided by the cumulative change in fair value of the underlying hedged item. Then compare the ratio results to the effectiveness threshold range of 80%-125%. When the ratio falls outside this range, we say the thresholds are 'breached'. When the ratio falls within the range, we say the ratio 'complies' with the thresholds. The overall effectiveness of the hedge is summarised by the 'compliance level', which is given by the percentage of compliant results. Hence a compliance level of 100% would mean that all results are compliant and there are no breaches:

$$\begin{aligned}\text{Compliance level} \\ &= \text{No. of compliant results / No. of data points} \\ &= 1 - (\text{No. of breaches / No. of data points})\end{aligned} \tag{4.1}$$

A hedge is considered to 'pass' this test if the compliance level is greater than, or equal to, the predefined 'compliance threshold'. For more information about the dollar-offset method, see Section 5.4.1.

The results of applying the dollar-offset test to the three hedging examples are shown in Tables 4.7- 4.9. From these it is evident that, if we were to interpret the 'pass' level in terms of a 100% compliance threshold, then the hedges in all three examples would fail, no matter how the changes in fair value were measured. This is because in all cases there are breaches of the thresholds.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Table 4.7: The results of dollar-offset effectiveness tests for Example 1

Test	Underlying	Hedging Instrument	Threshold Breaches	Compliance Level
1.	MTM	MTM	86%	14%
2.	Clean Price	MTM	88%	12%
3.	Clean Price	Clean Price	3%	97%

Table 4.8: The results of dollar-offset effectiveness tests for Example 2

Test	Underlying	Hedging Instrument	Threshold Breaches	Compliance Level
1.	MTM	MTM	70%	30%
2.	Clean Price	MTM	93%	7%
3.	Clean Price	Clean Price	10%	90%

Table 4.9: The results of dollar-offset effectiveness tests for Example 3

Test	Underlying	Hedging Instrument	Threshold Breaches	Compliance Level
1.	MTM	MTM	72%	28%
2.	Clean Price	MTM	86%	14%
3.	Clean Price	Clean Price	6%	94%

If on the other hand, we were to take account of the largely unfamiliar statistical properties of the dollar-offset ratio (see Canabarro (1999)), we would be inclined to set a compliance threshold of somewhat less than 100% — say 80%. In this case, the third test in each example, which involves comparing changes in the clean price value of the swap with those of the bond, generates 'pass' results since the achieved compliance levels (97% for Example 1, 90% for Example 2 and 94% for Example 3) are higher than the 80% compliance threshold.

It may seem surprising that there are so many breaches of the 80%-125% thresholds for these intuitively 'perfect' hedges, despite the very high correlation in several cases. Indeed the compliance levels for the first and second test in each example are exceedingly low! The reason for this is due to the statistical properties of the dollar-offset ratio, which are discussed in more detail in Section 5.4.1. Changes in the fair value that are very close to zero can give rise to extremely large dollar-offset ratios, and these can occur quite frequently. Because of this, the dollar-offset method can generate a large number of non-compliant results even for very highly correlated hedges. It is, therefore, generally not the most appropriate type of effectiveness test from an economic point of view.

4.4.2 Applying a risk reduction test

This sub-section describes the results of applying a risk reduction test to the three hedging examples. A risk reduction test is essentially a more statistically-literate version of the dollar-offset test. But instead of evaluating the *ratio of changes in fair value* of the hedging instrument to those of the underlying directly, this test evaluates the *ratio of the risk* of the hedge portfolio (the combination of the underlying hedged item together with the hedging instrument) to the risk of the underlying on a standalone basis. The better the hedging relationship, then the greater the relative risk reduction and the smaller this ratio will be. The relative risk reduction RRR is related to this ratio through the following equation:

$$RRR = 1 - (\text{risk of portfolio / risk of underlying}) \tag{4.2}$$

The results of applying the risk reduction test to the three hedging examples are shown in Tables 4.10-4.12. In this test we have measured risk in terms of the volatility, or standard deviation, of changes in fair value. So the test should be more properly called a 'volatility reduction' test. For more information on this test see Section 5.4.3.

In order to give this test a 'pass' or 'fail' grade, an appropriate effectiveness threshold needs to be defined. Hedges whose levels of relative risk reduction exceed the threshold will pass the test and will be considered to be 'highly effective'. But what threshold is appropriate for this test? In Section 2.4 we saw that a correlation of –80% corresponds to a level of risk reduction of approximately 40%. This suggests a highly effective threshold of 40% for the risk reduction test. In interpreting the results of this test with respect to the three examples, we assume that this is indeed the appropriate threshold level.

With this 40% risk-reduction threshold, all the tests in Tables 4.10 to 4.12 are passed, except the tests in Examples 2 and 3

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Table 4.10: The results of risk reduction effectiveness tests for Example 1

Risk is measured in terms of the volatility (standard deviation) of cumulative changes in fair value. The units are GBP millions.

Test	Underlying	Hedging Instrument	Volatility of Portfolio	Volatility of Underlying	Risk Reduction
1.	MTM	MTM	0.945	1.841	49%
2.	Clean Price	MTM	0.299	1.543	81%
3.	Clean Price	Clean Price	0.026	1.543	98%

Table 4.11: The results of risk reduction effectiveness tests for Example 2

Risk is measured in terms of the volatility (standard deviation) of cumulative changes in fair value. The units are EUR millions.

Test	Underlying	Hedging Instrument	Volatility of Portfolio	Volatility of Underlying	Risk Reduction
1.	MTM	MTM	0.581	2.160	73%
2.	Clean Price	MTM	1.198	1.619	26%
3.	Clean Price	Clean Price	0.020	1.619	99%

Table 4.12: The results of risk reduction effectiveness tests for Example 3

Risk is measured in terms of the volatility (standard deviation) of cumulative changes in fair value. The units are EUR millions.

Test	Underlying	Hedging Instrument	Volatility of Portfolio	Volatility of Underlying	Risk Reduction
1.	MTM	MTM	0.859	2.527	66%
2.	Clean Price	MTM	1.702	1.540	–11%
3.	Clean Price	Clean Price	0.096	1.540	94%

that compare the change in MTM value of the swap with the change in the clean price value of the bond. As in the other types of tests (regression and dollar-offset), using the clean price value to reflect changes in the fair value of the bond and the swap gives higher effectiveness results, because the problems associated with accrued interest are avoided.

4.5 Discussion: Lessons for effectiveness tests

In the above examples, we have shown that perfect fair value hedges of interest-rate risk do not give perfect results in effectiveness tests where such tests are implemented in the most common ways. The reasons for this paradox have been identified as being due to:

- mismatches in accrued interest,
- non-zero credit spreads,
- floating-rate swap legs do not precisely value to par.

None of these reasons, nor the results of the above tests, invalidates the fact that the swaps in the examples are intuitively perfect interest-rate hedges. In principle, these should also be perfect hedges under the standards. So why do the effectiveness tests give imperfect results? The answer is that the tests are too simplistic and have been poorly designed.

In fact it is *not possible* to design an effectiveness test that gives perfect effectiveness for the above perfect hedges when the test involves a direct comparison of the MTM value of a bond and an interest-rate swap. This is true regardless of whether or not accrued interest is included and regardless of how credit spreads are treated. To understand why consider our examples more carefully. In all cases the fixed leg of the swap matched the bond in all its terms and cash flows, thereby providing perfect offset in terms of changes in MTM value, provided it is valued with the same yield curve. So in comparing the changes in the bond MTM with that of the swap as a whole, they will be identical only if changes in value of the floating leg of the swap are precisely zero. This is rarely the case, and herein lies the problem with these effectiveness tests.

It is commonly assumed that floating-rate debt and floating swap legs value to par and this value does not change over the life of the instrument. While this is true on floating coupon reset dates, it is not true in general. Between reset dates the value of the floating leg varies firstly because of accrued interest and secondly because short-term interest rates fluctuate. So the change in value of a floating swap leg will in general be non-zero.

That the accrued interest has such a large impact on the effectiveness test results for the above examples is largely due to the fact that we are using a weekly data frequency to evaluate changes in MTM value. Because this (weekly) data frequency is higher than the (semi-annual) coupon payment frequency on the floating leg of the swap, the accrual period

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

since the last coupon payment date changes significantly at each weekly evaluation point (it varies from 0 to one week, to two weeks, ... to 6 months). This leads to a large variation in the amount of accrued interest, even if the interest rate does not change.

If the data frequency were to match the coupon payment frequency of the floating-rate leg of the swap (i.e., six-monthly in the examples), then the MTM value at each test evaluation point would have accrued its interest over the same amount of time, and the level of accrued interest would be very similar (differing mainly because floating rate coupons vary over time). Hence, one way to minimise the accrued interest problem is to choose a data frequency that is equal to, or less than, the floating-rate coupon frequency. For example, if the floating-rate coupon payment frequency is 2 times per year (semi-annual), then the data frequency should be 2 times per year (semi-annual) or 1 time per year (annual). If the floating-rate payment frequency is 12 times per year (monthly), then the data frequency should be 12 times (monthly), 6 times (bi-monthly), 4 times (quarterly), 3 times, 2 times (semi-annual), or 1 time per year (annual).

Unfortunately, it is not possible to use a semi-annual data frequency in all situations that involve semi-annual floating-rate coupon payments. This is because in order to get enough data points to perform a robust effectiveness test we need many years of historical data (60 data points would require 30 years of semi-annual data). In many markets this amount of historical data is not available and even when it is it may reflect different economic and market conditions that are not relevant for a forward-looking (prospective) hedge effectiveness test. Furthermore, backward-looking (retro-spective) tests may not be able to apply such a long history directly, because the underlying hedged item has a much shorter maturity. So, the inevitable conclusion is that a higher than optimal data frequency (i.e., shorter than optimal evaluation period between data points) will often need to be used, leading to the accrued interest problem discussed above.

The implications for effectiveness testing are clear. Even ignoring credit spread risk, the change in MTM value of a fixed-rate bond cannot be exactly the same as the change in MTM value of a perfect interest-rate swap hedge (except by accident or on dates on which the swap’s floating coupon is reset). This means we have to be much more careful in how we design effectiveness tests if we are to achieve complete economic consistency.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Chapter 5. HEAT: A consistent framework for hedge effectiveness testing

In this section we describe a consistent framework for evaluating hedge effectiveness, which we have called HEAT — Hedge Effectiveness Analysis Toolkit. This framework provides a structure upon which to implement a coherent and appropriate program for assessing the effectiveness of any kind of hedge. Although it has been motivated by the new accounting standards, it is based on very general principles and incorporates a significant amount of flexibility.

5.1 Overview of the HEAT framework

The HEAT framework provides corporations with guidance on different aspects of hedge effectiveness, including identifying the main steps in implementation, avoiding pitfalls and choosing between alternative methodologies. It is important to note, however, that this guidance is limited to risk management issues and expressly excludes any form of accounting advice.

Table 5.1: Key steps in the HEAT framework

Step 1: Define hedging objectives
- 1.1 Define underlying
- 1.2 Define designated risk
  - 1.2.1 Performance metric
  - 1.2.2 Risk class
  - 1.2.3 Amount of underlying being hedged
  - 1.2.4 Desired risk characteristics

Step 2: Select hedging instrument
- 2.1 Identify appropriate type of instrument
- 2.2 Identify appropriate instrument terms
- 2.3 Identify appropriate hedge ratio

Step 3: Select methodology for hedge effectiveness evaluation
- 3.1 Reference exposure
- 3.2 Fair value approach
- 3.3 Historical data to be used
- 3.4 Method of applying historical data
- 3.5 Maturity treatment
- 3.6 Basis for comparison
- 3.7 Type of effectiveness test

Step 4: Evaluate hedge effectiveness
- 4.1 Generate rate and price scenarios
- 4.2 Calculate changes in fair value
- 4.3 Perform effectiveness test

Step 5: Interpret effectiveness results
- 5.1 Apply effectiveness thresholds
- 5.2 Apply qualitative judgement

A key element of understanding hedge effectiveness is the concept of the perfect hedge, which has already been discussed at length. When applied to a specific hedging situation, we call the perfect hedge the *'Ideal Designated-Risk Hedge'* or IDRH. The IDRH is defined to be the perfect (or ideal) hedge for a particular underlying hedged item with respect to the designated risk. It clearly depends on the hedging objectives, the nature of the underlying and the designated risk being hedged.

The IDRH is important because it defines the standard against which all other hedges should be compared. In other words, it is the primary point of reference for understanding and evaluating hedge effectiveness. Even if the chosen methodology for evaluating effectiveness does not explicitly involve the IDRH, for that methodology to be credible and consistent it must be implicitly based on the IDRH concept. Hence the IDRH plays an important role in validating the economic appropriateness of different hedge effectiveness methodologies.

The HEAT framework involves five steps, which can be summarised as follows:

- Step 1: Define hedging objectives
- Step 2: Select hedging instrument
- Step 3: Select methodology for hedge effectiveness evaluation
- Step 4: Evaluate hedge effectiveness
- Step 5: Interpret effectiveness results

Sound risk management practice dictates that these steps should be carried out for any hedging activity, even if the accounting issues are not significant. Furthermore the steps must be well documented, particularly the hedging objectives (see for example, Kawaller (2002a)). We shall now describe each of these steps in detail (see Table 5.1)

Step 1: Define hedging objectives

Setting clear objectives is a crucial step in any hedging activity. These objectives must include defining the underlying hedged item and specifying the designated risk to be hedged. The latter involves several dimensions:

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

1. **Performance Metric:** Specify the primary performance metric that relates to the hedge, for example, cash flow or fair value. Constraints on other performance metrics should also be specified at this time, such as minimising earnings volatility.
2. **Risk Class:** Specify the risk class to be hedged, for example, interest-rate risk (benchmark interest rate), credit-spread risk, credit default risk, foreign exchange risk, commodity price risk, etc.
3. **Amount of underlying being hedged:** What percentage of the underlying exposure is to be hedged.
4. **Desired Risk Characteristics:** Specify the desired risk characteristics pertaining to the hedging relationship. For example, a fair value hedge of interest-rate risk generates a net interest-rate exposure to floating rates, which may be linked to different floating-rate indices, such as, 1-month Libor, 3-month Libor, 6-month Libor, Libor-in-arrears, average-rate Libor. In this case the desired risk characteristics reflect the selected floating-rate index. A second example, involves a cash flow hedge of interest-rate risk. This hedge involves replacing the underlying exposure to floating interest rates with either a completely fixed rate (e.g., 4%) or a rate that is fixed in a range (e.g., capped at 6% or collared between 2% and 5%).

As an example consider the following. Suppose the underlying is a fixed-rate bond issue. The performance metric in this case is fair value and the risk class is interest-rate risk, specifically the swap rate. Suppose that this entity is looking to fully hedge the bond, i.e., hedge 100% of the notional. Finally the desired risk characteristics after the hedge is implemented involve an exposure to floating interest rates, which in this example we assume is 3-month Libor.

Step 2: Select hedging instrument

On the basis of the hedging objectives outlined above in Step 1, it is generally (but not always) straightforward to identify an appropriate hedging instrument. To continue the example discussed above, the hedging objectives called for a fair value hedge of the interest-rate risk of the underlying bond, providing a net exposure to 3-month Libor. In this example, the obvious hedging instrument is an interest-rate swap, in which the corporation receives a fixed rate equal to the bond coupon and pays a floating rate linked to 3-month Libor. The fixed leg of the swap matches the bond in all critical terms.

A crucial element of this second step is identifying the appropriate *hedge ratio*. The hedge ratio determines how many units of the hedging instrument are used to hedge one unit of the underlying. Ideally, one would generally choose the optimal hedge ratio corresponding to maximal risk reduction (see Section 2.4.2).

However, it may be desirable for cash flow hedges to deliberately underhedge by selecting a hedge ratio that is lower than the optimal. This is because for cash flow hedges any actual ineffectiveness is only recognised in earnings when the ineffectiveness measurement corresponds to a so-called ‘overhedge’ situation, meaning that the actual change in fair value of the hedge is greater than the actual change in fair value of the hypothetical derivative representing the underlying (see Section 3.4). By selecting a slightly lower than optimal hedge ratio for cash flow hedges the likelihood of any ineffectiveness impacting earnings is reduced.

Step 3: Select methodology for hedge effectiveness evaluation

Selecting an appropriate hedge effectiveness methodology is vitally important, since an inappropriate choice can lead to spurious and misleading results. The choice of methodology includes several distinct elements:

1. **Reference exposure:** Should the hedging instrument be compared to the underlying hedged item or to an Ideal Designated-Risk Hedge (IDRH)?
2. **Fair value approach:** Should fair value be evaluated in terms of MTM value, or clean price value, or another approach?
3. **Historical data to be used:** How much history? What data frequency?
4. **Method of applying historical data:** How can the past be made relevant to the future?
5. **Maturity treatment:** Should one keep the maturities constant or allow the maturities to 'roll', i.e., fall over time?
6. **Basis for comparison:** Should one use cumulative changes or period-to-period changes?
7. **Type of effectiveness test:** Regression test, or dollar-offset test, or risk reduction test, or another type of test?

Each of these decision elements is discussed in greater detail below in Section 5.2.

JPMorgan

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Step 4: Evaluate hedge effectiveness

This step consists in actually performing the effectiveness test specified in the previous step. To do this we first generate a set of consistent and realistic scenarios for the designated risk over a number of time periods. Next we evaluate the fair value of the reference exposure (either the underlying or the IDRH) and the fair value of the hedging instrument in each scenario. Finally, we compute the change in fair value coming from changes in the designated risk and input these into the chosen test.

The output from any hedge effectiveness analysis depends on the type of test that is conducted. For a regression test, the output comprises two main elements: (i) the correlation between changes in the fair value of the reference exposure and those of the hedging instrument, and (ii) the slope of the regression (i.e., essentially the average ratio between the changes in fair value). If the reference exposure is the underlying hedged item then a perfect hedge should have a correlation of –100% and a slope of –1. If the reference exposure is the IDRH then a perfect hedge should have a correlation of +100% and a slope of +1 (i.e. the sign changes from negative to positive).

For a dollar offset (or ratio) test, the output comprises the ratio between the changes in fair value in each scenario. For a perfect hedge this ratio should be –1 or +1 depending on the reference exposure — unless the change in fair value of the underlying is zero, in which case the ratio cannot be computed.

Finally, for a risk reduction test the output corresponds to the level of risk reduction achieved by the hedge relative to the risk of the underlying exposure stand-alone. For a perfect hedge the relative risk reduction is 100%.

Step 5: Interpret effectiveness results

The results of any effectiveness test need to be interpreted in the context of the hedging objectives. This interpretation is usually facilitated by defining effectiveness ‘thresholds’ for the test, which provide an easy translation of the numerical results into a ‘pass’ or ‘fail’ signal.

For example, the thresholds for a regression test reflect the allowed range of deviation of both the correlation and the slope from their values for the perfect hedge. If the lower threshold is 80% and the upper threshold is 125%, then the regression test will give a pass result as long as the slope falls within the range of –0.80 to –1.25, and the result for the correlation falls within the range –80% to –100% (note that a correlation cannot be less than –100% or greater than 100%).

The thresholds for a dollar-offset test are slightly more complex. In fact there are two distinct types of threshold:

- **Ratio Thresholds:** These specify the permitted range of deviation for the ratio of the change in fair value of the hedging instrument over the change in fair value of the reference exposure (i.e., either the underlying or IDRH). For example, if the lower and upper thresholds are 80% and 125% respectively, then the ratio can vary within this band.
- **Compliance Threshold:** This specifies the required level of compliance with the above ratio thresholds. For example, if the compliance level is 90% this means that breaches of the ratio thresholds (e.g., 80%-125% range) are only permitted 10% of the time. If either of the ratio thresholds are breached more than 10% of the time then the hedge would fail this test.

Note that the latter compliance threshold is often overlooked in discussions of this method. However, it is essential if the dollar-offset method is to yield realistic and meaningful results.

The threshold for risk reduction tests reflects the minimal level of relative risk reduction necessary for a hedge to be considered ‘highly effective’. If, for example, the risk reduction threshold is 40% (corresponding to a correlation of –80% — see Section 2.4), then hedges that reduce the risk by more than 40% would be considered highly effective.

Note that the linkage between effectiveness thresholds and the true level of effectiveness is highly dependent on the effectiveness methodology, in particular, how much historical data is used and what type of test is being performed. Hence caution needs to be exercised in setting appropriate threshold levels for different tests.

Finally, it is important to recognise that the overall judgement as to whether a hedge is highly effective depends as

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

much on qualitative judgement as it does on quantitative results. The type of test performed, the way it is implemented and the inputs it requires must all be appropriate to the hedging situation.

5.2 Methodologies for hedge effectiveness

We have already emphasised the importance of Step 3 in the HEAT framework, namely, that of selecting an appropriate methodology for evaluating hedge effectiveness. In this section we discuss these methodologies in greater detail.

The HEAT framework embraces different methodologies and acknowledges the requirement to match the choice of methodology to each hedging situation. As we stated above, an inappropriate choice can lead to spurious and misleading hedge effectiveness results.

The choice of methodology includes several distinct elements which were briefly described in the previous section. Changing just one of these elements results in a different methodology.

5.2.1 Reference exposure

Defining the reference exposure is an important part of any effectiveness test. It involves choosing which instrument is to be used as the reference point for evaluating hedge effectiveness. The actual hedging instrument will be evaluated against this reference exposure in the effectiveness test. In particular, the change in fair value of the hedging instrument will be compared with the change in fair value of the reference exposure.

There are two possible alternatives for the reference exposure. The first alternative is to use the actual underlying hedged item as the reference exposure. In this case the change in the fair value of the actual hedging instrument will be directly compared with the change in fair value of the underlying hedged item. If the changes are identical in magnitude but opposite in direction, then the hedging instrument is the 'perfect hedge'. The second alternative is to use the perfect hedge, i.e., the IDRH, as the reference exposure. In this case the change in fair value of the actual hedging instrument will be compared with the change in fair value of the IDRH. If the changes are identical in both magnitude and direction, then the hedging instrument is the 'perfect hedge'.

See Section 5.3 for a detailed discussion of the issues regarding the use of the IDRH as the reference exposure.

5.2.2 Fair value approach

Fair value can be defined as the amount for which an asset, liability or derivative can be exchanged or settled between knowledgeable, willing parties in an arm's length transaction. However, the fair value of a financial instrument often cannot be directly observed in the market, but has to be inferred from observable market rates using a pricing model.

The element of choice associated with this part of the methodology is not how to measure fair value, since this is generally unique. Rather, the choice is how to measure *changes in fair value.* The changes in fair value that are relevant for hedge effectiveness are those due to the impact of the designated risk that is being hedged. Any changes due to the impact of other unrelated risks should be excluded from the calculation.

As an example, suppose a corporate issuer has implemented a fair value hedge of a particular debt issue, for which the designated risk is the benchmark interest rate (in this case the swap rate). For the purposes of testing the effectiveness of this hedge the relevant changes in fair value are those due only to changes in swap rates. Changes in fair value due to other risks, such as changes in the credit spread of the corporation over swaps, should be excluded.

Another example relates to the use of a forward contract to hedge the fair value of an available-for-sale security. The fair value of the hedged item (the security) is determined by its spot price, but the fair value of the hedging instrument (the forward contract) is determined by the forward price of the security. So any changes in the premium or discount between spot and forward prices will result in different price movements for the security and forward contract. In evaluating the effectiveness of this hedge the standards permit the corporation to exclude the impact of changes in the forward premium (or discount) from changes in the fair value of the

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

forward contract. This provides a much more appropriate measure of hedge effectiveness, but will lead to the changes in the forward premium or discount passing to earnings.

Yet another example of the choice of fair value methodology relates to the exclusion of accrued interest for interest-rate hedges. We call this the 'clean price approach,' since excluding accrued interest from changes in MTM value is the same as calculating changes in the clean price value. As we have already discussed in Chapter 4, excluding accrued interest from the changes in fair value of both the underlying hedged item and the hedging instrument can lead to more intuitive effectiveness results. To understand why this is the case, consider a one-year fixed-rate bond paying an annual coupon of 5%. At the time of issuance the bond has a price of par, i.e., 100. But at the instant before maturity the price of the bond is 105 (coupon + principle redemption). So over the life of the bond there is an upward drift in its fair value of 5% resulting from the accrual of the interest due. This drift is completely deterministic and has nothing to do with any risk factor. It is entirely due to the passage of time. As such it does not really belong in effectiveness tests for interest-rate hedges.

An operational reason why it is desirable to exclude accrued interest in particular effectiveness tests relates to the data frequency used in the test. Constraints on data availability and other factors often make it necessary to perform the effectiveness test with a data frequency that is monthly or weekly, which is a much higher frequency (and hence a shorter time horizon) than the reporting frequency. Suppose, for example, that the data frequency of the test is quarterly and we are evaluating a fair value interest-rate hedge of a fixed-rate bond involving a swap into 3-month floating Libor. In this case the data frequency is the same as the floating leg coupon frequency. This means that successive MTM valuations would involve an accrual period for the floating-leg of the swap that has a constant length, which is determined by the time between coupon payment dates and test evaluation dates. In this case the level of accrued interest across testing dates would be very stable. If, however, the data frequency were weekly, then successive MTM valuations would include a wide range of accrual periods, ranging from 1 week to 2 weeks, to 3 weeks, ... , to 12 weeks, leading to a widely varying level of accrued interest across the weekly evaluation dates. This variation in accrued interest leads to additional volatility in the swap MTM value, which is a direct result of the data frequency and does not reflect the level of variation that will be realised on the actual reporting dates. Therefore, if the data frequency used for hedge effectiveness tests is higher than the reporting frequency (i.e., the time period between test dates is shorter than that between reporting dates), then it becomes highly desirable to exclude accrued interest from the change in fair value.

We understand that, at the time of writing, corporations on both sides of the Atlantic are making operational use of the clean price approach in calculating changes in fair value for interest-rate hedges. Furthermore, feedback from the audit profession suggests that the clean price approach is widely considered an appropriate methodology under IAS 39.

5.2.3 Historical data

Regardless of the type of effectiveness test, historical data is needed to ascertain whether a proposed or existing hedge is likely to be highly effective. This historical data must include all the market rates, yields and prices needed to calculate a value for the hedged item, the IDRH (if relevant) and the hedging instrument.

The two key aspects of the historical data that are important to decide are:

- Length of history (i.e., how far back to go)
- Data frequency (e.g., 250, 52, 12, or 4 times per year), or equivalently the observation period (i.e., daily, weekly, monthly, or quarterly)

These are clearly interrelated. In general a lower data frequency (i.e., a longer period between observation dates) means that a longer history is required in order to obtain the same number of data points. For example, if 60 data points are needed for a regression analysis, the use of a quarterly data frequency requires 15 years of history, whereas the use of daily data requires only 3 month (approximately 60 business days) of history.

Ideally, the data frequency should be based on the hedge horizon (i.e., the full period of the hedging relationship) and the length of history should then be determined based on the relevant number of data points. However, the need for corporations to measure and report effectiveness results

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

quarterly (or, for many European companies, semi-annually) makes the maximal period between data points 3 months (or 6 months in the case of semi-annual reporting).

Periods of less than three months *can* be inappropriate for effectiveness testing and may give misleading results, because long-term correlations can be different from short-term correlations, and high-frequency data often has more 'noise' than low-frequency data. Furthermore, the problems associated with accrued interest discussed in Chapter 4 are largely caused by short observation periods.

However, the above problems are not always significant, and there are several reasons why short observation periods may be desirable in evaluating hedge effectiveness. For example a long enough history may not be available to give sufficient data points with quarterly data, or the available history may not be relevant to future market conditions because of structural change in the economy or market. Also if the maturity of the underlying hedged item is less than three months, then a shorter observation period is necessary.

In general, the choices relating to the length of history and data frequency will involve trade-offs and several factors need to be considered, including:

- The nature of the underlying hedged item and hedging instrument
- The nature of the hedging relationship
- The hedge horizon and maturity of the underlying compared with the reporting period
- The availability of historical data which is appropriate
- The characteristics of the data (e.g., seasonal and cyclical properties, structural changes, short-term vs. long-term statistical properties)
- The type of simulation in which the historical data is used (e.g., longitudinal historical simulation, cross-sectional historical simulation, or Monte Carlo Simulation - see the discussion in the Section 5.2.4)

In trying to overcome the challenges connected with historical data it may be tempting to use overlapping observation periods. However, data coming from overlapping periods are in general not independent. This lack of independence is measured by the *'autocorrelation'* and can lead to misleading hedge effectiveness results. There are methods for estimating and correcting for autocorrelation coming from overlapping periods (see for example Gujarati (1995: Ch12)), but these methods are not ideal and add additional complexity to the effectiveness test.

In order to get a statistically meaningful test result a minimal amount of historical data is needed. We recommend a minimum of 30 historical data points, although 40 to 60 are desirable. Bearing in mind the potential problems discussed above in relation to high-frequency data (short observation periods), a useful rule of thumb when selecting the data frequency is to consider the maturity of the underlying hedged item. For example, if the remaining maturity is longer than ten years, a suitable set of historical data might involve ten years of quarterly data, i.e., 60 data points. If the remaining maturity is five years, a suitable set of historical data might involve five years of monthly data, i.e., 60 data points. If the remaining maturity is one year, a suitable set of historical data might involve one year of weekly data, i.e., 52 data points. If the remaining maturity is less than one year, e.g., three months then a suitable set of historical data might involve three months of daily data, i.e., approximately 60 data points (since there are on average about 20 business days per month).

In general the decisions relating to historical data require judgement as to what is most appropriate for each hedging situation.

5.2.4 Method of applying historical data

Using historical data directly as a guide to future hedge effectiveness can be misleading. Historical yields and rates may be at very different levels from the current market and can lead to fair value results for the hedged item, IDRH (if relevant) and hedging instrument that are a long way from current valuations.

For a robust prospective (i.e., forward-looking) evaluation of hedge effectiveness it is generally necessary to perform a risk 'simulation'. This involves generating a large number of realistic scenarios for future interest rates, FX rates, etc. based on historical data. In implementing the risk simulation historical rates are used to build up scenarios for future rates which are consistent with both current market levels and historically-observed risks. This can be done in a number of different ways.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

A particularly simple simulation method is known as *'historical simulation'*. Historical simulation involves first calculating the relative changes in historical rates and then applying those changes to current market levels to generate future scenarios (see, for example, Mina and Xiao 2001).

As an example, suppose we have collected 61 monthly historical 10-year swap yields y_t over the past five years (including the current value). We first calculate the relative changes (or 'returns') in historical rates, which can be done in a number of different ways. A common way of calculating these relative changes is to take the natural logarithm of the ratio between consecutive swap yields as follows:

$$r_t = \log\ (y_t / y_{t-1}) \qquad t = 1,2,3,...,60 \qquad (5.1)$$

The next step is to apply these changes to the current swap level, which we denote s (= y_{60}). The result is a series of forward-looking scenarios for the 10-year swap yield, denoted z_t:

$$\begin{aligned} z_1 &= \exp\,(r_1)\ .\ s \\ z_2 &= \exp\,(r_2)\ .\ z_1 \\ z_3 &= \exp\,(r_3)\ .\ z_2 \\ &\text{etc.} \end{aligned} \qquad (5.2)$$

This procedure generates a single scenario for interest rates at each future time point over the next five years. Because the scenarios define a single path for future rates we call this *longitudinal historical simulation* (see Chart 5.1).

There is another way of generating scenarios from the relative changes in historical rates, which produces multiple scenarios but for just one future date (see Chart 5.2). This is called *cross-sectional historical simulation* and involves applying all the historical relative changes in rates to the current swap yield:

$$\begin{aligned} z_1 &= \exp\,(r_1)\ .\ s \\ z_2 &= \exp\,(r_2)\ .\ s \\ z_3 &= \exp\,(r_3)\ .\ s \\ &\text{etc.} \end{aligned} \qquad (5.3)$$

Longitudinal historical simulation is usually more appropriate for evaluating hedge effectiveness of long-maturity hedges over long time horizons. Cross-sectional historical

Chart 5.1: Longitudinal historical simulation

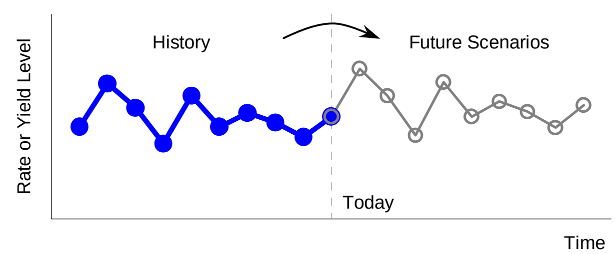
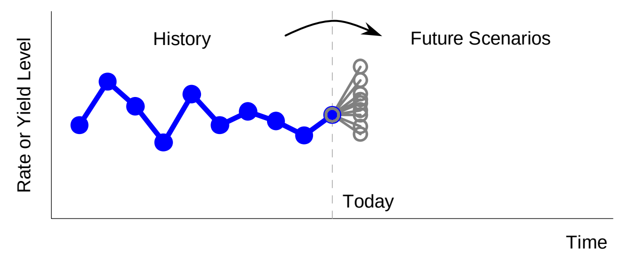


Chart 5.2: Cross-sectional historical simulation



simulation is usually more appropriate for evaluating hedge effectiveness of short-maturity hedges over short time horizons.

Historical simulation is widely used by financial institutions in risk simulations of FX rates, interest rates, equity prices, etc. (for more details on historical simulation, see for example, Mina and Xiao 2001).

Note that in practice, the simulation process for interest rates is generally applied not to par yields, but to zero-coupon yields. This actually involves starting with historical zero-coupon yield data (which can be calculated from historical par yields), applying the above formulae to generate scenarios for future zero-coupon yields, and then calculating scenarios for future par yields from these.

The historical simulation approach described above is not the only way to generate realistic scenarios for future rates, but it is a method that is well established, relatively simple to implement and transparent.

Another method that is more complex, but brings benefits in terms of statistical robustness, is so-called *'Monte Carlo simulation'*. Monte Carlo simulation essentially involves two steps. The first consists of estimating the volatilities and

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

correlations between the different market rates related to the designated risk. The second step is to apply these volatilities and correlations to the current market rates in order to generate scenarios for future rates.

Monte Carlo simulation is much more complex and less transparent than historical simulation, as the volatilities and correlations need to be carefully calibrated to the time horizon (or horizons) of the simulation, and more care must be taken to ensure the resulting scenarios are consistent and realistic. For further information, the interested reader should consult, for example, the *RiskMetrics Technical Document,* fourth edition (Longerstaey and Spencer 1996).

5.2.5 Maturity treatment

This refers to whether the maturity of the hedged item and hedging instrument is held constant or allowed to roll towards zero in successive time periods.

As an example of the constant maturity method consider a fair value interest-rate hedge of a five-year fixed-rate bond. Suppose we have used longitudinal historical simulation to generate 60 future interest-rate scenarios corresponding to month-end interest rates over the next five years. In each of the scenarios we assume that the hedged item and the hedging instrument have a maturity of five years at the start of the period and a maturity of 4 years 11 months at the end of the period. Hence the tenor remains constant across scenarios.

By contrast the rolling maturity method assumes that only at the start of the first period (i.e., today) is the maturity five years. At the start of the second period, which corresponds to the first scenario, the maturity is 4 years 11 months, at the start of the third period (the third scenario) the maturity is 4 years 10 months, etc.

The ideal choice is to use the rolling maturity method, since this more accurately reflects what actually happens over time. However, there are reasons why the constant maturity method may be more appropriate. For example, when the remaining maturity is very short it is not possible to perform a rolling maturity test using historical simulation with a sufficient number of data points.

For hedges of interest-rate risk, selecting constant maturity generally gives higher effectiveness. This is because the contribution to changes in value coming from shortening maturity and differing periods over which accrued interest is earned are minimised.

5.2.6 Basis for comparison

This refers to the choice as to whether the performance comparison between the reference exposure (hedged item, or IDRH) and the hedging instrument should be based on cumulative changes in fair value or period-to-period changes. Cumulative changes involve calculating for each reporting period the change in fair value from the inception of the hedge to the end of the current period. Period-to-period changes involve calculating for each reporting period the change in fair value from the end of the previous period to the end of the current period.

This choice will depend on the nature of the hedge, the nature of the risks involved, and the objectives behind the hedging decision. For example, for many hedges the period-to-period comparison has an advantage over the cumulative comparison because extreme one-off movements (spikes) in the relevant market rate impact just one data point, rather than many. On the other hand, the cumulative comparison frequently gives better results than the period-to-period comparison in normal market conditions. For instance, in each of the three examples presented in Chapter 4, the cumulative comparison resulted in higher effectiveness in virtually all the different effectiveness tests.

For cash flow hedges under the accounting standards, cumulative comparisons are the most economically sensible approach.

5.2.7 Type of effectiveness test

In Section 3.3 we discussed two main types of effectiveness test: regression analysis and the ratio test (‘dollar-offset’ method). As we saw in Chapter 4, the methods can give very different results. In particular, the latter can lead to spurious ineffectiveness results when changes in the fair value of the hedged item are very small.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

More specifically, when the change in the fair value of the hedged item is very close to zero, then the ratio defined by the change in the fair value of the hedging instrument divided by the change in the fair value of the hedged item will be very large. This can lead to a high degree of ineffectiveness in the dollar offset test, even though the change in fair value of both items may be very highly correlated.

Because of this, we recommend that corporations use, if possible, an alternative type of test such as regression analysis, or one of the risk reduction methods. All three types of test, along with the above problem with the dollar-offset test, are discussed in greater detail in Section 5.4.

5.3 The Ideal Designated-Risk Hedge (IDRH)

The *'Ideal Designated-Risk Hedge'* or IDRH, that was defined above, clearly depends on the underlying hedged item and the risk designated as being hedged.

The IDRH fits the concept of the perfect hedge both in terms of economic intuition (Section 2.2) and in terms of the accounting standards (Section 3.1). We have taken direct inspiration from the standards in developing the concept and in determining the IDRH for specific hedged items and designated risks. In particular, the short-cut method under FAS 133 essentially defines the IDRH for fair value hedges of interest-rate risk. The matched-term method under FAS 133 and the hypothetical derivative method under both standards essentially define the IDRH for particular cash flow hedges.

5.3.1 Determining the IDRH in practice

The accounting standards and the published guidance provide a suitable context for defining the appropriate IDRH in different circumstances. For example, the standards suggest that the critical terms of the IDRH and the underlying hedged item should match and that, where the IDRH is a swap, it should have zero value at inception. To make this more concrete consider some examples.

Consider a fair value interest-rate hedge of a bullet fixed-rate debt issue. The IDRH is a plain vanilla interest-rate swap with matching terms (same maturity, same currency, same notional, same fixed-rate cash flows, same fixed-rate coupon dates, etc.) for which the entity is paying a floating-rate coupon and receiving a fixed-rate coupon. The spread on the floating-rate coupon should be such that the swap is zero valued at inception. The only flexibility in defining the IDRH in this case relates to the floating leg of the swap, which may be chosen to be any floating-rate index allowed by the accounting standards (e.g. 1-month Libor, 3-month Libor, 6-month Libor, Libor-in-arrears, etc.), provided that choice is consistent with similar hedges.

Next consider a cash flow hedge of a floating-rate debt issue for which the designated risk is the variability of interest payment cash flows due to interest-rate volatility. The IDRH is again a plain vanilla interest-rate swap, but this time the entity pays a fixed-rate coupon and receives a floating-rate coupon. The floating leg of the swap matches the debt issue in terms of index, payment dates and spread. The size of the fixed-rate coupon should be such that the swap is zero valued at inception. The only flexibility associated with the IDRH is in terms of the payment frequency of the fixed leg of the swap.

5.3.2 Using the IDRH as the reference exposure

For cash flow hedges the use of the IDRH as the reference exposure corresponds to the 'hypothetical derivative' method discussed in the implementation guidelines to the accounting standards (See Box 3.9 in Section 3.4).

For fair value hedges, however, the use of the IDRH as the reference exposure does not correspond to any of the methods discussed in either of the standards or the associated guidance. However, it is our understanding that FASB views the 'hypothetical derivative' method as unsupportable for fair value hedges under FAS 133 because of the need to use all contractual cash flows (FAS 133.21(f)). Given this view, using the IDRH as the reference exposure for fair value hedges from a US GAAP perspective may prove difficult. This is unfortunate given the case in its favour is very strong in both economic and practical terms (see below). IAS 39 is not constrained by the need to use all contractual cash flows, as it focuses specifically on changes in fair value due to the designated risk. It is, therefore, potentially more flexible in implementation.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Using the IDRH as the reference exposure for hedge effectiveness has several advantages which we can summarise as follows:

1. It explicitly acknowledges the concept of a perfect hedge, which is implicit in the accounting standards.
2. It gives consistent effectiveness results for perfect hedges. The perfect hedge is equivalent to the IDRH and therefore will be 100% effective in all appropriate effectiveness tests.
3. It resolves the problems described in Chapter 4 associated with accrued interest in interest-rate hedges when comparing the changes in MTM value of a bond with its swap hedge. Because the actual hedging instrument is evaluated relative to the IDRH, we are comparing a two-leg instrument with another two-leg instrument and, therefore, there is no asymmetry in accrued interest.
4. It resolves the problems described in Chapter 4 associated with non-zero credit spread when hedging interest-rate risk. This is for the same reason discussed above for the accrued interest problem, namely, because we are comparing a swap (the actual hedging instrument) with another swap (the IDRH), rather than a swap with a bond.
5. It is identical to the hypothetical derivative method for evaluating cash flow hedges in both accounting standards.
6. It provides consistent and intuitive effectiveness results in fair value hedges of interest-rate risk, especially when the floating-rate index is set in arrears, e.g., Libor-in-arrears.
7. It is the only way in which derivatives qualifying for the short-cut method (see Section 3.1) under FAS 133 give the intuitive result of being 100% effective.
8. The identity of the IDRH is highly intuitive and the accounting standards provide considerable guidance of the properties of such a hedge. (See the discussion in Chapter 3).

The main criticism that can be levelled at this approach is that, in spite of the considerable advantages, we understand that FASB considers it unsupportable for fair value hedges as mentioned above. But even if it is not used directly in an effectiveness test, the IDRH is still important as a tool for education and aiding the understanding of hedge effectiveness. It defines the best possible economic hedge for any situation and is the reference against which all hedges should ultimately be compared. But most importantly, it plays a role in validating hedge effectiveness methodologies in terms of their economic appropriateness.

5.4 Alternative 'types' of effectiveness tests

In this section we compare and contrast the merits of different types of effectiveness tests. By 'type' of test we refer to the method used to translate the calculated changes in fair value into a hedge effectiveness test result. We examine three types of test: the dollar-offset method, regression analysis and the so-called risk reduction methods. For comparative reviews of these three types of test see Finnerty and Grant (2002), Althoff and Finnerty (2001), and Kawaller and Koch (2000).

5.4.1 Dollar-offset method

The dollar-offset method, or ratio test, is the simplest and most widely discussed type of effectiveness test. Unfortunately, as we shall see below, this simplicity comes at a price. The dollar-offset test does not give a realistic indication of the true level of effectiveness of a hedging relationship, given the way it is commonly implemented and interpreted. It produces frequent 'fail' results even for very highly correlated hedges. This is true even when the associated price movements are so small as to be insignificant from a business perspective. Several authors have discussed the shortcomings of this test, for example, Canabarro (1999), Althoff and Finnerty (2001), Kawaller (2001), and Finnerty and Grant (2002).

The starting point for the dollar-offset method, like other types of effectiveness test, is the set of changes in fair value ΔFV for both the underlying and the hedging instrument. From these changes the dollar-offset ratio DOR is calculated at each point in time (and for each scenario in a prospective test) as follows:

$$DOR = -\Delta FV_H \,/\, \Delta FV_U \qquad (5.4)$$

where ΔFV_H is the change in fair value of the hedging instrument over a given period and ΔFV_U is the change in fair value of the underlying hedged item over the same period.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

As we have mentioned elsewhere in this document, the widespread interpretation of what is acceptable for a 'highly effective' hedge under this test is a *DOR* result in the range of 80% to 125%. (For IAS 39, this is interpreted as an even tighter range for prospective tests). When the ratio falls outside this range, we say the thresholds are 'breached' and when the ratio falls within the range, we say the ratio 'complies' with the thresholds. The overall effectiveness of the hedge is summarised by the 'compliance level':

$$\begin{aligned}\text{Compliance level} &\\ &= \text{No. of compliant results / No. of data points}\\ &= 1 - (\text{No. of breaches / No. of data points})\end{aligned} \quad (5.5)$$

Many accounting and audit professionals interpret the condition to 'pass' a dollar-offset test in terms of complete —that is 100%— compliance with these thresholds. Unfortunately, this completely ignores the statistical nature of the test result, which realistically requires a compliance level of less than 100%. In other words, a certain percentage of results lying outside the thresholds is always to be expected on statistical grounds and should not invalidate the hedging relationship. This is because the 80%-125% threshold range is breached quite regularly, even by simple, intuitive and highly correlated hedges. This was clearly evident in the examples in Chapter 4. Moreover, changes in fair value that are very close to zero can give rise to extremely large ratios, leading to a spurious 'fail' result.

By way of illustration, consider the example given in Chart 5.3 and Table 5.2. The allowed threshold range of 80%-125% when expressed in currency units (e.g., euros, dollars, pounds, etc.) narrows virtually to nothing when the change in fair value of the underlying is very small. At the same time, the ratio can be very large, despite the fact that the change in fair value of the underlying and hedging instrument are close to each other in absolute terms. This is precisely what has happened in time periods 7, 8 and 12 in the example. In these periods the changes in fair value of both the underlying and the hedging instrument are very small and very close to each other. But the ratio between them is very large and the thresholds are breached.

To see just how regularly these breaches can occur, see Table 5.3. Even if the underlying and the hedge are highly correlated, there is still a significant probability that the ratio will lie outside the thresholds. For example, for a –90%

Table 5.2: Example of the dollar-offset calculation for 80%-125% effectiveness thresholds

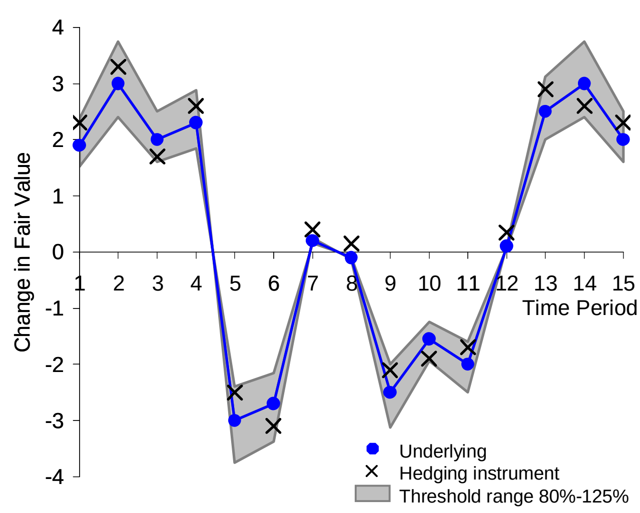
The dollar-offset ratio (*DOR*) is the change in fair value of the hedging instrument divided by the change in fair value of the underlying. Breaches are in bold type.

Time Period	Underlying*	Upper Threshold	Lower Threshold	Hedging Instrument*	*DOR*
1	1.90	1.52	2.38	2.30	121%
2	3.00	2.40	3.75	3.30	110%
3	2.00	1.60	2.50	1.70	85%
4	2.30	1.84	2.88	2.60	113%
5	-3.00	-2.40	-3.75	-2.50	83%
6	-2.70	-2.16	-3.38	-3.10	115%
7	**0.20**	**0.16**	**0.25**	**0.40**	**200%**
8	**-0.10**	**-0.08**	**-0.13**	**0.15**	**-150%**
9	-2.50	-2.00	-3.13	-2.10	84%
10	-1.55	-1.24	-1.94	-1.90	123%
11	-2.00	-1.60	-2.50	-1.70	85%
12	**0.10**	**0.08**	**0.13**	**0.35**	**350%**
13	2.50	2.00	3.13	2.90	116%
14	3.00	2.40	3.75	2.60	87%
15	2.00	1.60	2.50	2.30	115%
...	...	...	...	...	...

** Change in fair value over each time period*

Chart 5.3: Example of the dollar-offset chart for 80%-125% effectiveness thresholds

The plotted points reflect the change in fair value of the underlying and the change in fair value of the hedging instrument. Breaches correspond to points outside the shaded 80%-125% effectiveness range.



Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

correlation between the underlying and the hedging instrument, there is a staggeringly large probability of 71% that the 80%-125% thresholds will be breached. Even for a –99% correlation, the probability is still 36%, i.e., more than one in three results will breach the thresholds! Tighter thresholds will produce even more breaches, for example, for the same –99% correlation there is a 77% probability that the narrower 95%-106% range will be breached. This means three out of every four results will be outside these thresholds!

To understand why this is the case, consider a simple but realistic model of changes in fair value like the one presented in Section 2.4. We first make what are very reasonable assumptions about the underlying hedged item and the hedging instrument:

- Changes in fair value are normally distributed
- The average change in fair value is zero
- The volatility (standard deviation) of the changes in fair value of the underlying and hedging instrument are the same
- The changes in fair value of the underlying and hedging instrument have a correlation of ρ (which is negative).

Under these assumptions, we can straightforwardly calculate the probability that the dollar offset result will be outside any given range. In particular, the probability that the ratio is less than any threshold value T is given by the cumulative Cauchy distribution (see Canabarro (1999)):

$$\text{prob}(\,DOR<T) = 1/2 + 1/\pi\ .\ \arctan[\ (T+\rho)\ /\ \sqrt{(1-\rho^2)}\ ] \qquad (5.6)$$

Table 5.3: Probability of the dollar-offset ratio lying outside threshold ranges for varying correlations.
The correlation corresponds to that between the change in fair value of the underlying and the change in fair value of the hedging instrument.

	Probability of being outside the range	
Correlation	80%-125%	95%-106%
–99%	36.2%	76.5%
–98%	46.8%	83.1%
–95%	61.4%	89.2%
–90%	71.3%	92.4%
–80%	79.5%	94.8%
–50%	87.9%	97.0%
0%	93.0%	98.3%

In this equation, T is a threshold (e.g., 0.80 or 1.25) and ρ is the (negative) correlation between the fair value changes of the underlying and hedging instrument. So the probability of being outside the 80%-125% range is:

$$\text{prob}(\,DOR \text{ lies outside } 80\%\text{-}125\%) = \text{prob}(DOR<0.80) + [1 - \text{prob}(DOR<1.25)] \qquad (5.7)$$

It is from this expression that the probabilities in Table 5.3 have been calculated. Because the Cauchy distribution has 'fat' tails, indeed much 'fatter' than the more familiar normal distribution, there is a very high probability of an extreme value which will be outside the range.

The conclusion we draw from all this is that the dollar-offset method is not really appropriate as an effectiveness test, unless allowances are made for the high frequency of non-compliance. To do this it is necessary to define a compliance threshold for the test and evaluate the actual level of compliance relative to the threshold. But given the difficulties that there will be in explaining the problems associated with this test to non-specialists we recommend that it should not be used for effectiveness testing.

5.4.2 Regression analysis

As discussed in Section 3.3, regression is a statistical technique for analysing the relationship between a dependent variable and one or more independent variables. It is significantly more complex than the dollar-offset method and requires appropriate care and understanding in its application and interpretation. It is not enough to identify a relationship between the variables, one must also verify that the analysis is appropriate and the result is significant.

Several authors have written about regression in the context of hedge effectiveness testing, see for example, Kawaller and Steinberg (2002), Kawaller (2002b), Althoff and Finnerty (2001), Royall (2001), and Kawaller and Koch (2000). For more general information about regression analysis, see for example Gujarati (1995).

The starting point for regression analysis is a suitable set of data points, which should, first of all, be plotted on a scatter chart to provide a visual perspective on the possible relationship. Regression involves evaluating a 'best-fit' line through the cluster of points to characterise the average

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

relationship between them. The 'tightness' of the points around the regression line provides an indication of the strength of the relationship and the potential size of the errors when the line is used for prediction.

If we let x denote the independent variable and y the dependent variable, then the regression line between the two variables can be written mathematically as:

$$y = \alpha + \beta \,.\, x \tag{5.8}$$

Usually x is taken to be the change in fair value of the underlying hedged item and y the change in fair value of the hedging instrument. The regression analysis itself involves identifying the values of the slope β and the intercept α that minimise the sum of the squares of the errors, or residuals, between the line and the actual data points. The interpretation of the slope is that it corresponds to the inverse of the optimal hedge ratio defined in Section 2.4. In other words, the optimal hedge ratio is:

$$h^* = -1 / \beta \tag{5.9}$$

The optimal hedge ratio means that we are hedging one unit of the underlying with h^* units of the hedging instrument. The slope must be negative if the reference exposure is the underlying and positive if the reference exposure is the IDRH. Furthermore, if the actual hedge is based on a one-for-one hedging relationship, as it will typically be for interest-rate swap hedges but not necessarily for other hedges (e.g., commodity price hedges), then the slope should be close to –1. As long as the actual hedge ratio is equal to the optimal hedge ratio (which is equal to the inverse of the slope) then any value for the slope is acceptable.

Once the slope and intercept have been determined it is important to check the size of the errors, or equivalently the 'tightness' of the data points around the regression line. This tightness reflects the likelihood of achieving a high degree of effectiveness in a hedge effectiveness test. The closer the points are to the line, then the higher the effectiveness. This can be measured in terms of the 'correlation coefficient' and the so-called 'R-squared coefficient'.

The correlation coefficient varies between –1 and +1, and measures the extent and direction of the relationship between the two variables. A correlation of +1 indicates a perfect positive relationship: as x increases then so does y. On the other hand, a correlation of –1 indicates a perfect inverse relationship: as x increases then y decreases. Finally, a correlation of zero indicates that there is no predictive relationship at all between the variables.

The R-squared is just the square of the correlation coefficient and varies between 0 and +1. It can be thought of as measuring the proportion of the variance of the dependent variable y that can be explained by independent variable x.

An important part of a regression analysis involves establishing its statistical significance, i.e., validity. A statistical test known as a t-test can be used to perform this task. The t-test involves calculating what is called a t-statistic, which

Table 5.4: An example of output from regression analysis
The analysis corresponds to Example 1 in Chapter 4, where changes in fair value are measured in terms of cumulative changes in clean price value.

Regression Statistics	
Correlation Coefficient	-0.99992
R Square	0.99985
Adjusted R Square	0.99985
Standard Error	0.00019
Observations	260

Analysis of Variance

	df	*SS*	*MS*	*F-statistic*	*Significance F*
Regression	1	0.06303	0.06303	1680102	0
Residual	258	9.7E-06	3.8E-08		
Total	259	0.06304			

	Coefficients	*Standard Error*	*t Statistic*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept α	-0.00027	1.7E-05	-15.40	2.1E-38	-0.00030	-0.00023
Slope β	-1.01116	0.00078	-1296.19	0	-1.01270	-1.00962

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

can be translated into a significance level for the regression result, which is usually referred to as the p-value (e.g., p = 0.05 denotes a 5% significance level). From the significance level, one can calculate a confidence level which is given by 100% – p (e.g., for a significance level of 0.05, the confidence level is 95% = 100% – 5%).

Table 5.4 shows an example of the output from a regression analysis. It is based on Example 1 in Chapter 4, where changes in fair value are measured in terms of clean price value. The results are directly comparable with the figures for Test 3 of Example 1 shown in Table 4.4.

All regression software products calculate the t-statistic and significance level, in addition to the R-squared, slope and intercept. For further information, the reader should consult a suitable text-book, such as Gujarati (1995).

Table 5.5: A checklist for regression analysis of hedge effectiveness

1. Data should be appropriate and representative. A bare minimum of 30 data points, preferably more.
2. Data should reflect changes in fair value over a time horizon that is the same or less than the term of the hedging relationship.
3. Regression should usually be formulated in terms of changes in fair value of the hedging instrument as a function of changes in fair value of the underlying hedged item.
4. Consider whether it is appropriate to perform regression of fair value *levels* instead of, or in addition to, *changes* of fair value.
5. Review visually a scatter diagram of the data points and their distribution around the fitted regression line. An unbiased regression should have residuals (errors) which appear random with a constant standard deviation.
6. The regression results for the correlation (or R-squared) should be better than the threshold values, e.g., correlation < –80%.
7. The hedge ratio used in the implementation of the hedging relationship should be close to the inverse of the slope $1/\beta$. That is the 'optimal hedge ratio' is used.
8. The t-test is passed at the 95% confidence level.
9. The y-intercept is close to zero. It may even be appropriate to force the intercept to be zero.
10. The regression results are intuitively and appropriately related to the hedging relationship.

Unfortunately statistical tests can only go so far in terms of justifying a particular regression analysis result. The real validity of any regression result will ultimately be based on a judgement of its appropriateness and relevance, derived from a qualitative understanding of the hedging situation, as well as the quantitative output. A practical checklist for performing regression analysis is summarised in Table 5.5 (see Royall (2001)).

5.4.3 Risk reduction methods

Both regression analysis and the dollar-offset method involve pairwise comparisons of the changes in fair value of the underlying hedged item and the hedging instrument. While such pairwise comparisons provide important information about hedge effectiveness, they do so indirectly. A more direct approach to evaluating the effectiveness of a hedge is to calculate its degree of risk reduction. This involves a comparison of the risk of the combined portfolio (the underlying together with the hedging instrument) with the risk of the underlying stand alone. For a hedge to be 'effective', the risk of the portfolio should be lower than that of the underlying, that is, the degree of risk reduction should be positive. This is precisely the definition of hedge effectiveness we discussed in Section 2.4.

Risk reduction methods for evaluating hedge effectiveness involve calculating the risk of the combined portfolio along with the risk of the underlying, and then calculating the relative risk reduction:

$$RRR = 1 - (\text{risk of portfolio} \,/\, \text{risk of underlying}) \tag{5.10}$$

The result of a calculation of relative risk reduction depends on how risk is measured. Different risk measures have been used in evaluating hedge effectiveness, including the *variance* of changes in fair value (Johnson (1960) and Ederington (1979)), the *value-at-risk,* or VaR (Humphreys (2000)), and the *volatility,* or standard deviation, of changes in fair value (Kalotay and Abreo (2001)).

Of these risk measures volatility is particularly well known and very convenient for the purpose of evaluating hedge effectiveness. As discussed in Section 2.4, with volatility as the risk measure the degree of relative risk reduction is given by:

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

$$RRR = (\sigma_U - \sigma_P) \;/\; \sigma_U \qquad (5.10)$$

where σ_U is the standard deviation of changes in the fair value of the underlying and σ_P is the standard deviation of changes in the fair value of the portfolio, both over the same time horizon. When risk is measured in terms of volatility in this way, the relative risk reduction is also called the 'volatility reduction measure' or VRM. It was first discussed in the context of FAS 133 by Kalotay and Abreo (2001).

There are several advantages to this type of test. In addition to being consistent with the economic view of hedge effectiveness (Section 2.4), the VRM test involves a metric — volatility— that is already familiar to portfolio managers and treasury staff. Furthermore, it is much easier to communicate to senior managers, accountants and analysts than R-squared values or correlations. In particular, it can be expressed as a monetary amount (in dollars, euros, pounds, etc.) that directly reflects the risk to a corporation's earnings performance. Similar advantages apply to using VaR as the risk measure. In fact VaR is particularly suitable for option-related hedges because (unlike volatility) it is a downside risk measure, that takes account of the asymmetric nature of options. However VaR is generally more difficult to calculate, unless changes in fair value are normally distributed, in which case VaR is directly proportional to the volatility.

The VRM test is related to the dollar-offset method, in that it gives the same result when it is applied to a single set of changes in fair value. If the mean expected change in fair value of the underlying and hedging instrument can be assumed to be zero, then the standard deviation is the same as the *single change in fair value* over one evaluation period:

$$\begin{aligned} \sigma_U &= \Delta FV_U \\ \sigma_P &= \Delta FV_U + \Delta FV_H \end{aligned} \qquad (5.12)$$

and the relative risk reduction for this *single change in fair value* is:

$$\begin{aligned} RRR &= (\sigma_U - \sigma_P) \;/\; \sigma_U \\ &= -\Delta FV_H \,/\, \Delta FV_U \\ &= DOR \end{aligned} \qquad (5.13)$$

which is just the dollar-offset ratio. (Of course this relationship does not hold if we consider more than one set of changes in fair value). This shows that the VRM method, and indeed other risk reduction methods, are essentially just versions of the simple dollar-offset method that are more statistically literate.

An important question that arises in implementing risk reduction methods is: What is an appropriate risk reduction threshold for a hedge to be considered 'highly effective'? For the answer we can relate the amount of risk reduction back to the correlation as we did in Section 2.4. In Section 2.4 we saw that a correlation of –80% corresponds to a level of risk reduction of approximately 40%. That is, the two are statistically the same. Therefore if a correlation threshold of 80% is considered an appropriate threshold for a hedge to be highly effective in a regression test, then a highly effective threshold of 40% for the risk reduction test is consistent with this.

The amount of risk reduction achieved by any hedging instrument can be maximised by a careful choice of hedge ratio. The optimal hedge ratio h^* was defined in Section 2.4.2 as the hedge ratio that minimises the overall risk of the portfolio, or equivalently, maximises the level of risk reduction. If changes in fair value are normally distributed, then the optimal hedge ratio is given by equation (2.6):

$$h^* = -\rho \,.\, (\sigma_U \;/\; \sigma_H) \qquad (5.14)$$

where σ_U and σ_H are the standard deviations of changes in the fair value of the underlying and the hedging instrument respectively, and ρ is the (negative) correlation between them.

An example of implementing the VRM test is shown in Table 5.6. The data in the table correspond to Example 1 in Chapter 4 (see Table 4.10 in Section 4.4). It should be apparent from the table that the implementation of this test is relatively simple. It merely involves calculating the standard deviation of the changes in fair value for both the underlying and the hedge portfolio. This ease of implementation, combined with their economically intuitive nature and straightforward interpretation, make risk reduction methods well suited to hedge effectiveness testing.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Table 5.6: An example of output from a VRM risk reduction test
The analysis corresponds to Example 1 in Chapter 4, where changes in fair value are measured in terms of cumulative changes in clean price value.

	Weekly Change in Fair Value (% of notional)		
Week Ending	Bond	Swap	Portfolio
12-Mar-97	-0.1756	0.1700	-0.0056
19-Mar-97	1.2303	-1.2478	-0.0175
26-Mar-97	1.4424	-1.4647	-0.0223
02-Apr-97	1.6694	-1.6958	-0.0265
09-Apr-97	1.2325	-1.2621	-0.0296
16-Apr-97	1.0453	-1.0779	-0.0326
23-Apr-97	1.1969	-1.2392	-0.0423
.	.	.	.
.	.	.	.
.	.	.	.
16-Jan-02	-0.429	0.412	-0.017
23-Jan-02	-0.368	0.356	-0.013
30-Jan-02	-0.306	0.290	-0.016
06-Feb-02	-0.240	0.232	-0.008
13-Feb-02	-0.188	0.166	-0.022
20-Feb-02	-0.121	0.110	-0.012
27-Feb-02	-0.055	0.051	-0.004
Volatility (%)	1.543	1.560	0.026
Relative Risk Reduction			98.3%

5.5 Example: Hedging currency risk

In this section we examine an example of evaluating effectiveness for a hedge of foreign exchange (FX) risk. Hedges of FX risk generally lead to more straightforward effectiveness tests than hedges of interest-rate risk. There are two main reasons for this:

- A large range of FX hedges can be designated as cash flow hedges, for which effectiveness is much easier to evaluate. For these cash flow hedges one need only define a hypothetical derivative (essentially the IDRH) to represent the hedged item and then, using this as the reference exposure, compare its changes in fair value with those of the actual hedging instrument.
- Changes in fair value due to FX risk are generally much larger than changes in fair value due to interest-rate risk. This is because FX volatility is considerably higher than interest-rate volatility. The implication of this is that the problems associated with accrued interest and non-zero credit spread will have a much lower impact on effectiveness test results.

A common FX hedging situation for many corporations involves swapping foreign-currency debt back into the functional currency. There are four different cases for this situation, depending on whether the original foreign currency debt is fixed or floating, and whether it is swapped back into fixed or floating. They are:

1. Fixed-rate bond issued in foreign currency
   Hedge back into functional currency fixed rate
   Fixed-to-fixed cross currency swap
   This is a cash flow hedge of FX risk

2. Fixed-rate bond issued in foreign currency
   Hedge back into functional currency floating rate
   Fixed-to-floating cross currency swap
   This is a fair value hedge of FX risk and interest-rate risk

3. Floating-rate bond issued in foreign currency
   Hedge back into functional currency fixed rate
   Floating-to-fixed cross currency swap
   This is a cash flow hedge of FX risk and interest-rate risk

4. Floating-rate bond issued in foreign currency
   Hedge back into functional currency floating rate
   Floating-to-floating cross currency swap
   This is a cash flow hedge of FX risk, or a fair value hedge of FX risk. (Some accountants believe that this can only be designated as a fair value hedge under FAS 133).

Since the cases that involve cash flow hedges are straightforward, we focus on case 2: hedging a foreign currency fixed-rate bond into a floating-rate liability in the functional currency. Consider the example of a corporation with euro functional currency issuing a sterling fixed-rate bond with terms identical to the bond discussed in Example 1 in Chapter 4.

5.5.1 Example Step 1: Define hedging objectives

The underlying hedged item is a GBP 100 million five-year fixed-rate bond with a coupon of 7.29% issued in GBP on 5 March 1997. The terms are defined in Table 4.1. The designated risk defined as follows:

- **Performance metric:** Fair value
- **Risk class:** FX risk and interest-rate risk
- **Amount of underlying hedged:** 100% (i.e., GBP 100 mm)
- **Desired risk characteristics:** EUR 6-month Libor

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

5.5.2 Example Step 2: Select hedging instrument

The hedging instrument is a five-year cross currency swap whose receive leg has a fixed-rate coupon of 7.29% in GBP with the same terms as the bond, and whose pay leg has a floating rate coupon in EUR linked to 6-month Libor. The swap has a fair value of zero at inception.

The hedge ratio is 100%, meaning that we are hedging the GBP 100 million bond with a swap notional of GBP 100 million on the receive leg. The pay leg of the swap has a notional of EUR 142.5 million, based on the spot FX rate at inception.

5.5.3 Example Step 3: Select methodology for hedge effectiveness evaluation

The methodology used for evaluating hedge effectiveness on this retrospective basis is the same as that used in Chapter 4. It is defined as follows:

- **Reference exposure:** The underlying bond
- **Fair value approach:** Full fair value
- **Historical data to be used:** Actual market data for GBP and EUR interest rates (swap rates) and for the GBP/EUR FX rate between 5 March 1997 and 5 March 2002, with a weekly data frequency
- **Method of applying historical data:** Use actual past data directly, as this is a retrospective test
- **Maturity treatment:** Rolling maturities for bond and swap
- **Basis for comparison:** Cumulative changes in fair value
- **Type of effectiveness test:** Three types of test are used: dollar-offset method, regression analysis, volatility reduction method

5.5.4 Example Step 4: Evaluate hedge effectiveness

Evaluating hedge effectiveness involves first calculating the changes in fair value of the underlying hedged item and the hedging instrument from the historical data. For the underlying, this involves valuation of the bond in its local currency (GBP) and then translation of that value into functional currency (EUR). Chart 5.4 shows the cumulative changes in the fair value of the underlying bond over the five-year period in both local currency and functional currency. The changes in fair value in local currency reflect the impact of

Chart 5.4: Currency hedging example. Cumulative change in MTM value of the bond in local currency and functional currency

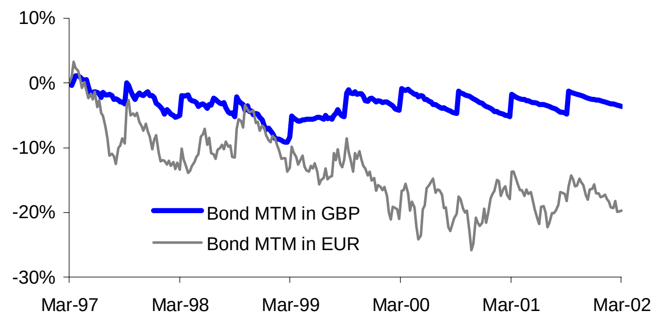
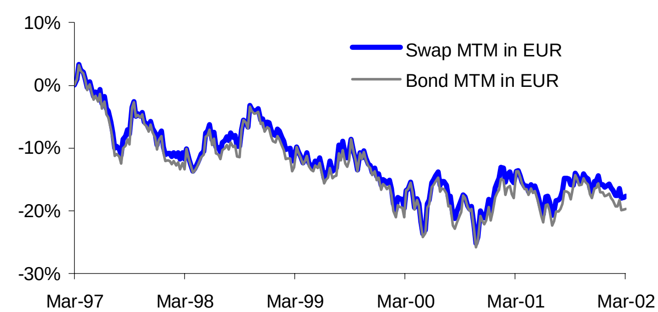


Chart 5.5: Currency hedging example. Cumulative change in MTM value of the bond and the swap in the functional currency



GBP interest-rate risk, while the changes in fair value in functional currency reflect the impact of GBP interest-rate risk and GBP/EUR FX risk. Comparing these clearly demonstrates the higher volatility associated with FX risk. The weekly volatility of the bond in its local currency (GBP) over the period is 1.8% of the bond's GBP 100 million notional. By contrast the weekly volatility in terms of the functional currency is 5.7% of the initial notional amount in euros (EUR 141.5 million).

Chart 5.5 shows the cumulative changes in fair value for both the underlying (the bond) and the hedging instrument (the cross currency swap) in the functional currency. Note that the changes in fair value of the swap tracks those of the bond very closely. The differences are largely due to the accrued interest problem discussed in Chapter 4, but they are smaller in relative magnitude owing to FX volatility being much larger than interest-rate volatility.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

The changes in fair value in functional currency terms shown in Charts 5.4 and 5.5 are used as inputs for the three effectiveness tests that we discuss in Step 5.

5.5.5 Example Step 5: Interpret effectiveness results

To interpret the results of any hedge effectiveness test first requires a clear definition of the effectiveness thresholds. In this example, we apply the following effectiveness thresholds:

- **Dollar-offset test:** Ratio threshold range –80% to –125%, compliance threshold 80%
- **Regression test:** Correlation threshold –80% to –100%, slope threshold –0.80 to –1.25
- **Volatility reduction test:** Risk reduction threshold 40%

All three effectiveness tests produce consistent pass results for this hedge, relative to the defined effectiveness thresholds. This is clearly evident in Tables 5.7, 5.8 and 5.9.

The dollar-offset test results are shown visually in Chart 5.6. Note that over almost the entire range the actual change in fair value of the swap (i.e., the hedging instrument) is well within the effectiveness thresholds. Only in the period between April and June 1997, where the changes in fair value of the underlying bond are small, are the thresholds breached.

Table 5.7: The results of the dollar-offset effectiveness test for the currency hedging example
Based on cumulative weekly changes in fair value in EUR.

Underlying	Hedging Instrument	Threshold Breaches	Compliance Level
MTM	MTM	4%	96%

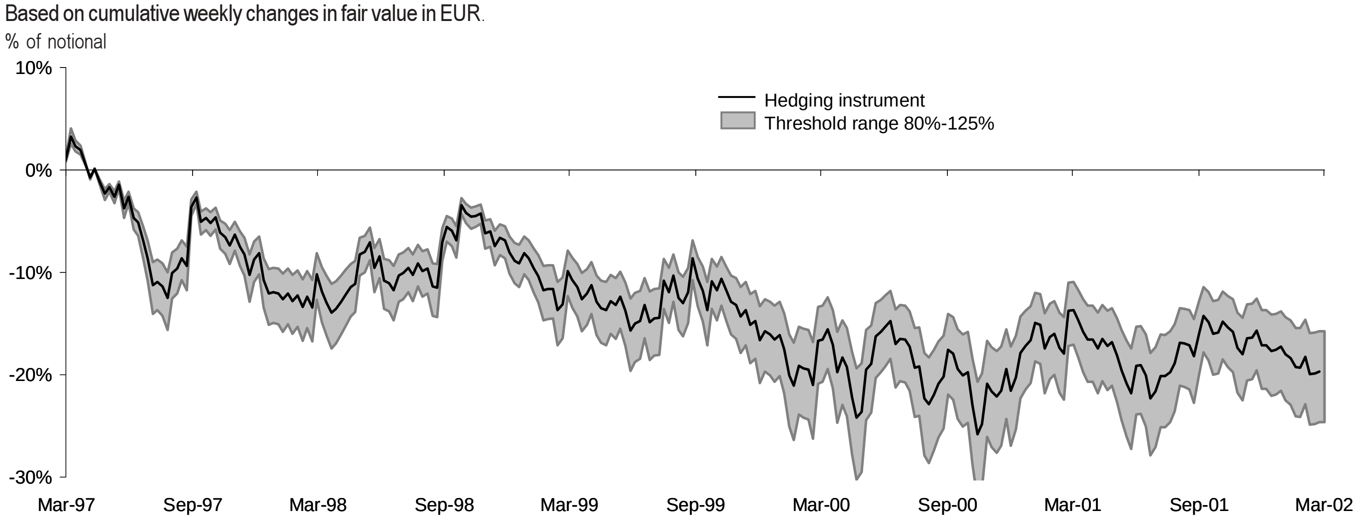
Table 5.8: The results of the regression effectiveness test for the currency hedging example
Based on cumulative weekly changes in fair value in EUR.

Underlying	Hedging Instrument	Correlation	Slope
MTM	MTM	99.5%	0.96

Table 5.9: The results of the risk reduction effectiveness test for the currency hedging example
Risk is measured in terms of the volatility (standard deviation) of cumulative weekly changes in fair value. The units are EUR millions.

Underlying	Hedging Instrument	Volatility of Portfolio	Volatility of Underlying	Risk Reduction
MTM	MTM	0.59	5.70	90%

Chart 5.6: Dollar-offset ratio and the effectiveness threshold range for the currency hedging example.
Based on cumulative weekly changes in fair value in EUR.



Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
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The regression analysis is shown visually in the scatter plot in Chart 5.7. The tight spread of points around the regression line suggests a high correlation and a significant regression. In fact the t-statistic is high 161.9, implying a *p*-value which is virtually zero, and hence a confidence level very close to 100%. The intercept is also suitably small.

The VRM test results are illustrated visually in Chart 5.8. The difference in the volatility of changes in MTM value before and after hedging is clear from the two lines. The cross currency swap gives a significant reduction in risk, measured in terms of volatility. Note that the shape of the line representing the change in fair value of the hedge portfolio (bond + swap) is a direct result of the accrued interest on the floating-rate EUR leg of the swap. If clean price value were used instead of MTM value, or if the observation period were longer (e.g., six-monthly) then the line would be virtually flat.

The conclusion that should be drawn from this effectiveness analysis is that, based on the tests as defined above, the hedging instrument, i.e., the cross currency swap, provides a highly-effective hedge and, therefore, should qualify for fair value hedge accounting treatment under the accounting standards.

Chart 5.7: Currency hedging example. Scatter plot of cumulative change in MTM value of the swap vs. those of the bond

The changes are % amounts in the functional currency (EUR).
% of notional

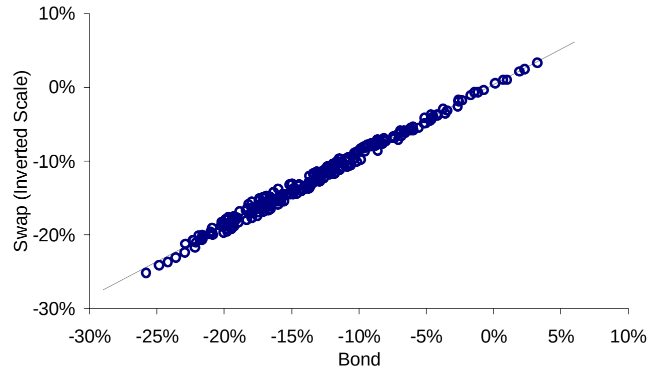
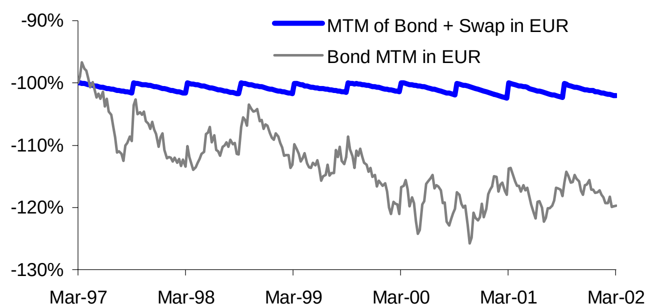


Chart 5.8: Currency hedging example. Scatter plot of cumulative change in MTM value of the bond vs. those of the hedge portfolio

The changes are % amounts in the functional currency (EUR).
% of notional



5.6 Impact of hedges without hedge accounting

Most corporations will use hedge effectiveness tests in order to qualify for hedge accounting treatment, wherever possible. However, there will always be situations in which hedge accounting treatment is either not available, not desirable, or not required. In these situations, the changes in fair value of the derivative must be reflected in earnings.

Let us examine these situations in more detail. First, hedge accounting treatment may not be available, despite there being real economic benefits to hedging, simply because the accounting standards are not fully aligned with economic performance. Secondly, gaining hedge accounting treatment for a derivative may not be desirable if there are already offsetting risks in the income statement (e.g., another offsetting derivative or other exposure). The change in the fair value of the derivative may then provide a suitable hedge of existing earnings volatility, without the need for hedge accounting. Thirdly, the changes in fair value of a hedging derivative may not be material compared with the size of earnings and the other contributions to earnings volatility. In this case, the low level of additional volatility coming from the derivative can be absorbed directly into the income statement without the need for hedge accounting treatment. This avoids the administrative burden of evaluating and documenting hedge effectiveness.

In all these situations, corporations need to evaluate the potential earnings volatility resulting from such hedges. This involves evaluating the standard deviation of the changes in fair value of the derivative. The changes in fair value used to estimate the impact on earnings volatility should be based on period-to-period changes, rather than cumulative changes, since this is what will actually be reflected in earnings. Furthermore, when the time period for measuring changes in fair value is less than the reporting period, then

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

fair value should be evaluated in terms of the clean price value, which excludes accrued interest. This is essentially for the same reasons discussed in Section 5.2.2, namely that including accrued interest overstates the actual impact on earnings volatility because of the greater variation in the length of accrual period.

The point of the above discussion is to highlight the fact that corporations should *not* automatically avoid hedging simply because a hedge does not get favourable hedge accounting treatment, nor should they automatically seek hedge accounting treatment for every derivative. Instead, they should do the following:

- Verify the economic benefit of the proposed hedge
- Evaluate the earnings volatility of the proposed derivative hedge on a stand-alone basis
- Evaluate the marginal contribution of the derivative to total earnings volatility, taking account of other related risk exposures
- Make a judgement as to whether the additional earnings volatility is material, or whether it is immaterial and can be absorbed into the income statement
- Make a judgement as to whether other risk elements in the income statement provide sufficient hedging benefits to reduce the impact of the derivative on total earnings volatility

These steps enable corporations to decide whether to proceed with an economic hedge even though it does not qualify for hedge accounting treatment, and whether hedge accounting treatment is even necessary. An important implication of this is that the management of a corporation's hedging programme requires its derivative portfolio to be split into two sub-portfolios:

- Accounting-Compliant Hedges: Derivatives that qualify for hedge accounting treatment and for which effectiveness must be verified
- Pure Economic Hedges: Derivatives that are considered purely economic hedges, that don't qualify for hedge accounting treatment and whose contribution to earnings volatility must be managed

For hedges that fall into the first category hedge effectiveness must be evaluated and monitored as we have discussed. However, derivative hedges that fall into the second category are effective economic hedges but the accounting statements do not recognise this. These hedges should be managed taking account of their economic benefit versus their contribution to overall earnings volatility on a portfolio basis. Corporations that aim to maximise shareholder value will manage these hedges by defining overall risk limits for earnings volatility for the entire portfolio of pure economic hedges. The earnings-at-risk associated with this portfolio will then be managed within the specified risk limits. This is similar to how banks use value-at-risk limits to manage their trading books, except that the focus for corporations will not be on daily value-at-risk, but rather on quarterly or annual earnings-at-risk.

5.7 Summary

The ultimate objective of any framework for hedge effectiveness evaluation is to ensure that hedging instruments are appropriate and that they actually play a meaningful role in reducing risk. In this chapter we have assembled the elements that can be used to define a consistent, robust, practical and intuitive approach for evaluating hedge effectiveness. HEAT is not a rigid or prescriptive set of rules, but rather a flexible framework incorporating a range of alternative methodologies. The framework and the methodologies should be tailored to fit both the overall risk management strategy of each corporation and the full range of specific hedging situations that are relevant to that company.

As we have emphasised throughout this document, from an accounting perspective the appropriateness of a particular methodology for evaluating hedge effectiveness will ultimately be determined by each corporation's auditor. Corporations must, therefore, seek advice from their professional accounting advisors before implementing a particular methodology.

JPMorgan

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

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Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Appendix

Glossary of working definitions

Accrued Interest: This is the amount of interest that a debt instrument or a swap has earned to date, but which has not yet been paid in the form of a coupon. The formula for calculating accrued interest on a bond or swap is:

$$\text{Accrued Interest} = \text{Notional} \times \text{Coupon rate for period} \times \frac{\text{Days since last coupon payment}}{\text{Days in coupon period}}$$

In practice, this formula is only approximately correct because of so-called day-count conventions, which vary from market to market.

Cash Flow Hedge (Accounting Definition): A hedge of the exposure to variability in cash flows that (1) is attributable to a particular risk associated with a recognised asset or liability (such as all or some future interest payments on variable rate debt) or a forecasted transaction (such as an anticipated purchase or sale) and that (2) will affect reported net profit or loss.

Cash Flow Risk: The uncertainty associated with the timing and/or size of future cash flows.

Clean Price: The clean price of an instrument is defined to be the MTM value of the instrument excluding accrued interest. The clean price of a bond is a well known concept in bond markets, as most bonds are quoted and traded in terms of their clean price. For swaps the concept of clean price value is a straightforward extension of this. Accrued interest is calculated for each leg of the swap and the net amount subtracted from the MTM value of the swap.

Commodity Price Risk: The uncertainty in the market price of commodities.

Credit Spread Risk: This reflects the uncertainty in the market price of a financial instrument due to possible changes in the credit quality of the obligor. This is usually measured in terms of the credit spread over a benchmark interest rate.

Credit Default Risk: The risk that one party to a financial instrument will fail to discharge an obligation and cause the other party to incur a financial loss.

Critical Terms: The conditions which underpin a derivatives contract, i.e., the notional amount, currency, repricing dates, floating rate index, etc. FAS 133 and IAS 39 outline that if the critical terms of the *hedging instrument* and *hedged item* match, the changes in fair value or cash flow attributable to the *designated risk* will offset fully. For example, an interest rate swap is likely to be a highly-effective hedge if the notional and principal amounts, term, repricing dates, dates of interest and principal receipts and payments, and basis for measuring interest rates are the same for the hedging instrument and the hedged item. Critical terms are also called *Principal Terms*.

Currency Risk: The uncertainty in the value of an asset, liability or derivative due to variability in foreign exchange (FX) rates. Also known as *FX risk*.

Designated Risk: This refers to the risk factor that is specified as the object of hedging relationship.

Dollar-Offset Method: This is a common type of hedge *effectiveness test.* More precisely, it is a specific method for comparing the changes in fair value of the underlying hedged item which are due to the designated risk, with those of the hedging instrument. It involves evaluating the so-called dollar-offset ratio, which is the ratio of changes in the fair value of the *hedging instrument* divided by the changes in the fair value of the *underlying hedged item.* The ratio is then compared with an acceptable range of outcomes, e.g., 80%-125%, which defines the *effectiveness thresholds* for a *highly-effective* hedge. Also called *ratio analysis*.

Effectiveness Testing: This refers to the process of evaluating the extent to which a hedge has been, and is likely in the future, to be *highly effective.* An effectiveness test determines whether a hedge qualifies for *hedge accounting* treatment.

Effectiveness Thresholds: These are somewhat arbitrary 'hurdle' levels that must be achieved in any hedge effectiveness evaluation if the hedging relationship is to be classified

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

as *'highly effective'* under the accounting standards. Note that in order to be consistent, different types of test must have different effectiveness thresholds. For the *dollar-offset method* a range of 80%-125% is commonly interpreted as defining the thresholds for a hedge to be considered highly effective. For a *regression analysis* suitable effectiveness thresholds for the correlation might be a range of 80%-100%. (Under IAS 39 the 'almost fully offset' prospective test is interpreted as a tighter range). Also referred to as the *highly effective thresholds*.

Fair Value: The amount for which an asset, liability or derivative can be exchanged or settled between knowledgeable, willing parties in an arm's length transaction. The fair value of a financial instrument often cannot be directly observed in the market, but has to be inferred from observable market rates using a pricing model. Also known as *marked-to-market value* or MTM value.

Fair Value Hedge (Accounting Definition): A hedge of the exposure to changes in the fair value of a recognised asset or liability, or an identified portion of such an asset or liability, that is attributable to a particular *designated risk* and that will affect reported net income.

FX Risk: See *currency risk.*

HEAT: HEAT is an abbreviation for 'Hedge Effectiveness Analysis Toolkit'. It provides a framework and toolkit for understanding and implementing hedge *effectiveness testing.* HEAT enables entities to select an appropriate effectiveness methodology from a range of possibilities.

Hedge Accounting: This is a favourable accounting treatment, which reduces the volatility of earnings coming from derivatives which are qualifying hedges. Under hedge accounting, an entity is permitted to match offsetting changes in the value of the *hedging instrument* with those of the *hedged item,* so that the changes are recognised in the income statement in the same period.

Hedge Effectiveness: The degree to which changes in the performance of an underlying *hedged item,* attributable to a *designated risk,* are offset by changes in the performance of a designated *hedging instrument*.

Hedged Item (Accounting Definition): An asset, liability, firm commitment, or forecasted future transaction that (a) exposes the enterprise to the risk of changes in fair value or changes in future cash flows and that (b) for *hedge accounting* purposes, is designated as being hedged.

Hedging Instrument (Accounting Definition): A designated derivative or (in limited circumstances) another financial asset or liability whose fair value or cash flows are expected to offset changes in the fair value or cash flows of a designated *hedged item.* A non-derivative financial asset or liability may be designated as a hedging instrument for *hedge accounting* purposes only if it hedges the risk of changes in foreign currency exchange rates.

Hedge Ratio: The amount of the *hedging instrument* used to hedge one unit of the underlying *hedged item.*

Highly Effective: A hedge is 'highly effective' if it passes the *effectiveness thresholds* for the chosen *effectiveness test.* A highly-effective hedge qualifies for *hedge accounting* treatment.

Highly Effective Thresholds: See *effectiveness thresholds.*

Hypothetical Derivative Method: This is a method for evaluating the effectiveness of cash flow hedges. It involves defining a hypothetical derivative hedge against which the actual hedging instrument should be evaluated. This hypothetical derivative fits the intuitive notion of a *perfect hedge* for the designated risk. It can be regarded as completely equivalent to the HEAT concept of the *Ideal Designated-Risk Hedge,* or IDRH.

Ideal Designated-Risk Hedge (IDRH): This is defined to be the perfect (or ideal) hedge for a particular *underlying hedged item* with respect to a *designated risk.* The IDRH is important for two reasons. First, it defines the standard against which all other hedges should be compared. Second, it plays an important role in validating the economic appropriateness of hedge effectiveness methodologies. Although they are essentially the same concept, we distinguish the IDRH from the perfect hedge in order to emphasise the accounting context associated with the former. See *perfect hedge*.

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank

Ineffectiveness Measurement: The process of determining the monetary amounts that are to be recognised in the current period income statement in relation to a designated hedging relationship. See *measurement.*

Interest-Rate Risk: The uncertainty in the value of an asset, liability or derivative, or in the amount or timing of cash flows, that is due to variability in interest rates.

Marked-to-Market Value (MTM value): See *fair value.*

Matched-Term Method: Under this method, where the *critical terms* of the *hedging instrument* and *hedged item* match as part of a cash flow hedge, FAS 133 assumes that the hedge is fully effective without the need to undertake any numerical hedge effectiveness or ineffectiveness measurement. This is providing the critical terms are formally reviewed over the life of the hedge to ensure a continued match, and that counterparty credit risk has not deteriorated. Note that this method is not applicable under IAS 39.

Measurement (Accounting Definition): The process of determining the monetary amounts at which the elements of the financial statements are to be recognised and carried in the balance sheet and income statement.

Net Investment in a Foreign Entity: This refers to the reporting entity's investment in the net assets of a foreign entity.

Perfect Hedge: This is a hedge that is perfectly effective over the life of the hedging relationship, such that changes in the performance of the hedge precisely offset the changes in the performance of the underlying hedged item, in respect of the designated risk being hedged. See *Ideal Designated-Risk Hedge.*

Principal Terms: See *critical terms*.

Ratio Analysis: See the *dollar-offset test*.

Regression Analysis: This is a type of effectiveness test, which is an alternative to the *dollar-offset method* and the *risk reduction method.* Regression analysis is a statistical technique used to analyse the relationship between a dependent variable and one or more independent variables. By taking historical data, this analysis can be applied to predict how the dependent variable is expected to vary with changes in the independent variable. In assessing hedge effectiveness, the dependent variable would normally be the change in fair value of the hedging instrument and the independent variable the change in fair value of the hedged item.

Risk Reduction Method: This is a type of effectiveness test, which is an alternative to the *dollar-offset method* and *regression analysis.* It involves measuring the amount of risk reduction achieved by the hedge (underlying + hedging instrument), relative to the risk of the underlying on a stand-alone basis.

Short-Cut Method: This applies to situations where an interest-rate swap is hedging the interest rate risk of an interest-bearing asset or liability. For hedging relationships which meet the conditions of this method, FAS 133 assumes that the hedge is fully effective and that there is no ineffectiveness recognised in earnings over the life of the relationship. The conditions include the requirement that all *critical terms* match and that the fair value of the swap at inception is zero. Note that this method is not applicable under IAS 39.

Underlying: This is a term referring to the *hedged item* in a hedging relationship. Also referred to as the 'underlying hedged item'.

Value-at-Risk (VaR): A metric of risk. VaR is defined as the worst-case fall in fair value over a specified horizon with a given confidence level (usually a 95% or 99% confidence level). Unlike *volatility,* VaR is a metric of downside uncertainty. VaR depends on the time horizon over which changes in fair value are evaluated.

Volatility: A metric of risk. Volatility corresponds to the standard deviation of changes in fair value, cash flow, market prices, or financial rates. The changes can be measured in absolute, or percentage, or logarithmic terms. Unlike *value-at-risk,* volatility reflects a combination of both downside and upside uncertainties. Volatility depends on the time horizon over which the changes are evaluated, but it is frequently quoted in annualised form by dividing by the square root of the time horizon in years.

Volatility Reduction Method (VRM): A particular type of *risk reduction method* in which risk is measured in terms of *volatility.*

Guy Coughlan (44-20) 7777-1857
J.P. Morgan Securities Ltd.
Johannes Kolb (44-20) 7777-1301
Simon Emery (44-20) 7777-4128
JPMorgan Chase Bank